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Male Combat in American Colubrid Snakes with Remarks on Combat in Other Colubrid and Elapid Snakes

By Charles E. Shaw

Some attention has recently been directed toward the description and interpretation of the so-called "combat dance" between males* of several North American snakes. Previous to the discussions and observations of Lowe (1948) and Shaw (1948), and due primarily to lack of, or inaccuracy in, identification of the sex of the individuals involved, such behavior had been interpreted by some observers as a "courtship dance" of male and female. Lowe (1948) and Lowe and Norris (1950) have presented summaries of such behavior as observed in colubrids, elapids, viperids, and crotalids.

Published accounts of this interesting behavior relating to American snakes have, however, concerned members of the family Crotalidae for the most part. Woodbury (1941) appears to have been the first to describe male combat in American colubrid snakes, this author reporting a struggle between two male *Pituophis melanoleucus deserticola* at Great Salt Lake, Utah. Hansen (1950) has recorded a second instance of fighting between two male *Pituophis m. deserticola,* also from Utah. More recently Tinkle (1951) has observed an instance of intersubspecific combat in *Drymarchon.*

The present paper adds four additional forms to the American colubrids in which combat between males has been noted; these are *Pituophis melanoleucus melanoleucus, Pituophis melanoleucus annectens, Elaphe guttata guttata* and *Lampropeltis doliata annulata.* In all instances sex has been determined by eversion of hemipenes.

The following discussion is based in greater part on the behavior of captive specimens of *P. m. melanoleucus* at the reptile house of the San Diego Zoo. Observations of the behavior of these snakes have been made during two breeding seasons, 1949 and 1950. In 1949 the first sexual activity was noted on February 8 and continued almost daily until April 4. In 1950 the breeding period extended from February 28 to March 31 with "combat dancing" a common occurrence throughout this period. During both years a total of 8 adult specimens, 4 males and 4 females, were confined in a cage with a floor space of about 5 feet by 9 feet and about 8 feet in height, and containing a large rein-

* A single instance of what appears to be combat (*Crotalus atrox*) in which the sexes have been accurately determined as male and female has been reported by Whisenhunt (1949).

forced concrete tree extending from the floor to the ceiling. The snakes were all captive bred, having been hatched from eggs incubated at the reptile house in 1940 and 1941. All 8 snakes were approximately 6 feet in length.

Courtship Behavior in *Pituophis m. melanoleucus*

The observations of C. B. Perkins (1943) appear to represent the only published account of courtship and copulation in this subspecies. This report has been supplemented by additional observations also made at the San Diego Zoo in 1943, 1947, and 1950 in order to present a more complete picture of the courtship behavior as well as to furnish a more adequate basis for comparison with the combat behavior exhibited by the males of this snake.

Normal activity in these snakes as shown by observations made shortly before the onset of obvious breeding activities, consists of a great deal of aimless wandering over the cage floor as well as a continual nosing and pushing at the glass front of the cage. At the beginning of definitely recognizable breeding activities and through the period in which the snakes are sexually active, only the males are normally very restless, continually moving about the floor of the cage as if engrossed in an unsuccessful search. On the other hand, the females, although occasionally making some movement such as rearranging the position of the body or crawling to a new resting position, show a definite lack of the extensive and almost continuous movements of the males at this time. As a rule the females are almost totally inactive, lying quietly coiled (fig. 1*; note female in lower left hand corner) and appearing completely oblivious of the activities of the males. In fact it would appear as if the females were deliberately trying to escape the notice of the males. Occasionally the males rest for relatively short periods, but usually at least one or two are actively wandering over the cage floor. A male in the "blue" stage prior to shedding behaves in the same manner as a female, that is, completely passive, and takes no part or interest either in the activities of the other males or in courting the females. The males are very alert to any sudden movement either on the part of other snakes in the cage or even objects outside the cage. Once, when I threw a burnt match over my shoulder, all four males dashed wildly toward me, running headlong into the glass front of the cage. In another instance a passing bus immediately attracted all males to the glass front of the cage. Noble (1937) has described the dashing about of male and female *Coluber c. constrictor* during the breeding season and believes that such action "stimulates the whole group to greater sexual activity." The same author also stresses the role of movement in the courtship of *Thamnophis*.

The males of *P. m. melanoleucus* frequently court or make preliminary courting gestures such as flicking the tongue over the body of the female while moving alongside her or over her back. The female either elects to remain entirely passive to such proceedings or appears to indicate her annoyance with such contact by making a sudden, rapid dash across the cage, usually with the tail held up at an angle to the cage floor and lashed from side to side. Not always, however, is this behavior directly caused by an investigating male, for frequently a passive and physically unannoyed female in a coiled resting position will suddenly and without apparent reason make a swift dash across the cage. This behavior on the part of a female arouses the males to a frenzy of action, those in a position to observe this rapid movement either dashing wildly after the female or after other males that may be pursuing her. The

* Photographs by G. E. Kirkpatrick

female has always been observed to stop as abruptly as she seemed to start, and, almost invariably, the sudden cessation of her movement causes a pursuing male or males to lose complete track of her. The male or males following the female appear to make an extensive search by means of the tongue over the sand in the immediate vicinity, but none has been observed to follow any possible scent trail left by the female. Although the female may lie only a few inches away from the male or males attempting to find her, she is seldom discovered and then apparently only accidentally rather than as a result of having been trailed by a male.

Should the female choose to remain passive to the investigatory advances of an interested male, however, the male may succeed in courting her without having her flee. The male orients himself so that he crawls forward over her back. While thus engaged there are muscular rippling movements in the ventral body wall and lower lateral surface of the body of the male. The rippling movements may be confined to a particular area of the male's body or may occur simultaneously at several points on the ventrolateral surface of the male. The body of the male is thrown in undulating fashion over that of the female and he may rub his body back and forth over hers in slow, jerky undulations. The muscular rippling movements and the undulations of the male's body over that of the female may occur simultaneously, but also may be employed separately. As the male's head attains a position on the neck of the female he may withdraw the anterior part of his body a short distance and work slowly forward over her back again. While these actions are taking place the tail of the male is twitched from side to side almost continuously over that of the female. At frequent intervals the tail twitching of the male increases in tempo, becoming almost frenzied, and at the same time approximately the posterior one-third of his body is rapidly undulated over the posterior of the female's body. At the peak of his increased excitement a loop or wedge of the male's tail is thrown under (but not completely around) the female's tail and his tail is then rubbed up and down on that of the female. After a few seconds of this stroking, the male may lift the female's tail as much as two inches or so off the floor of the cage and at an angle to it, evidently in an attempt to bring the cloacae of the pair together. At no time has a male been observed to evert a hemipenis nor has any swelling in the cloacal region been noted; but the tails are usually so closely adpressed that such actions might easily pass unnoticed.

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An apparently important though perhaps not invariable feature of the courtship of this snake as noted by Perkins (1943) and subsequently, is a biting hold of the female by the male. Such a hold is taken either on the neck of the female or may encompass the back of the head as well as part of the neck. The function of the biting hold in the snakes which employ such a grip as part of their courtship behavior is thought by Noble (1937) to serve as a means of stimulating the female. A similar grip employed by many lizards serves the same purpose as stated by Noble and Bradley (1933). It may be that such a grip by the male additionally prevents the female from suddenly fleeing as noted above. Unfortunately in our observations we have not actually witnessed the initiation of this biting grip by a male so it is impossible to state whether the grip is obtained during the pursuit of a fleeing female or whether a female may be suddenly seized while passive; in all probability the seizure of a female may take place under either circumstance. As has been observed on one occasion, even though a secure neck or head hold may be obtained by a male, it may be broken after a prolonged and vigorous effort by a struggling female if she does not desire to submit to the attentions

of the male. In this single instance there was no action that might possibly be interpreted as combat between male and female in the sense of the stereotyped stance and ritual demonstrated by two combatant males. In three courtships that have terminated in copulation, the male was observed to have a biting hold on the back of the head and neck of the female in two instances. Perkins (1943) notes that a courting male with a secure neck grip on a female later released her but continued courting. This courtship did not result in any observed copulation. Lack of a biting hold by a male during copulation does not necessarily indicate that it has not been employed at some stage of courtship, however. Once the pair becomes united in copulation the grip would appear unnecessary having already served its presumed purpose of stimulation of the female. Although the male's grip on the female may continue until the termination of copulation, such a hold seems needless as a means of compelling the female to remain with the male. The spinose hemipenis would certainly prevent the female from escaping the male once the pair had become united as has been pointed out by Noble (1937) for *Storeria*. Such seems to have been the case in a pair of *P. m. melanoleucus* noted by C. B. Perkins on January 9, 1945. At 11:05 a.m. a male was observed in copulation with a female. He did not have a grip on the female at this time and both snakes were crawling in opposite directions apparently trying to separate, but held fast together by the right hemipenis of the male. The female waved her tail from side to side in apparent annoyance. At 11:20 a.m. both snakes were more quiet and it was noted that the male had revolved several times on his longitudinal axis as shown by the twisted hemipenis. At 11:30 a.m. the male was moving or revolving about constantly. At 11:45 a.m. the female was dragging the male backwards about the cage and the male was revolving. At 11:49 a.m. both snakes jerked free; the male, picked up at once, had already retracted the hemipenis.

Combat Behavior in *Pituophis m. melanoleucus*

During the breeding period as noted above under courtship behavior, the males are very actively prowling about the cage while the females customarily remain almost completely inactive as if to escape the notice of the males. A sudden dash across the cage by a female, arousing the males to quick pursuit, may lead to combat between males, although not always. Pursuit of a female usually involves at least two males, and at the abrupt ending of the female's flight, the pursuing males may become involved with one another after having lost track of the female.

One of the males may crawl alongside or forward over the back of another male. Activity of this sort on the part of an aggressive male may be completely ignored or more often may elicit considerable nudging by the other male. That is, the non-aggressive male may attempt, with more or less violence, to throw the aggressive male aside with repeated sidewise or upward thrusts of a loop of his body. If the aggressive male persists in his actions he eventually reaches a position in which the heads and necks of both snakes are either alongside one another or the aggressor directly overlies the body of the other male. As soon as the heads and necks of the two males are in an opposed position or nearly so, both snakes, with the anterior 6 to 8 inches of the head and body drawn back into a short striking position, with head pointed forward, but with an exaggerated side loop of the neck, begin a winding together of their bodies (figs. 1, 2, and 3). One of the males raises the anterior looped portion of his head and body up and over the head and neck of the other male and places it on the cage floor; the other male immediately responds

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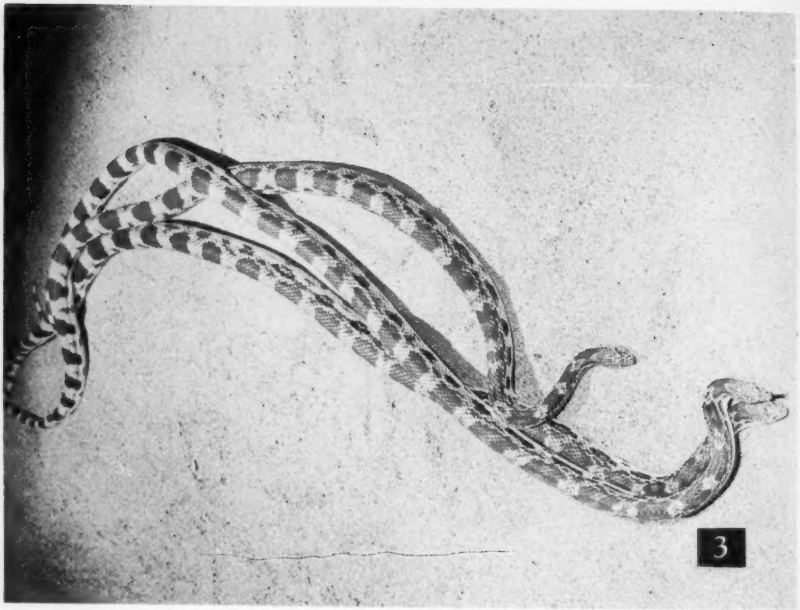
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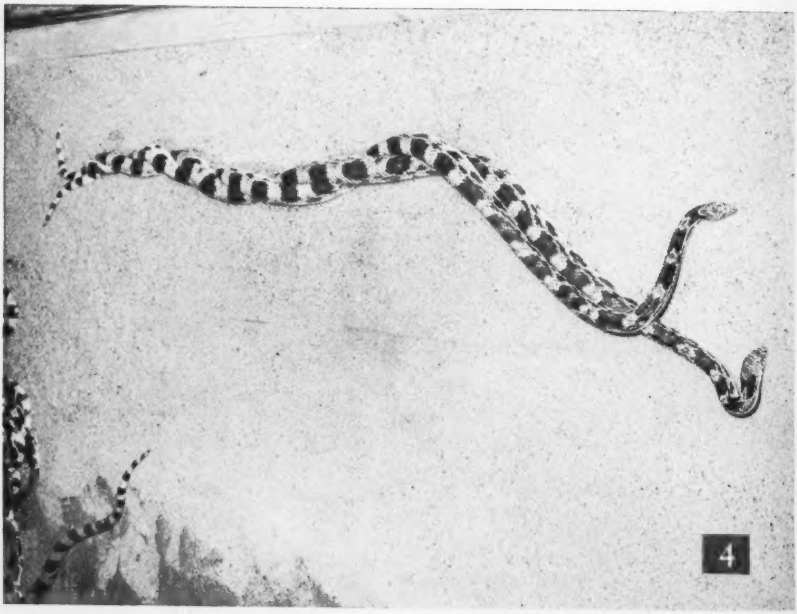
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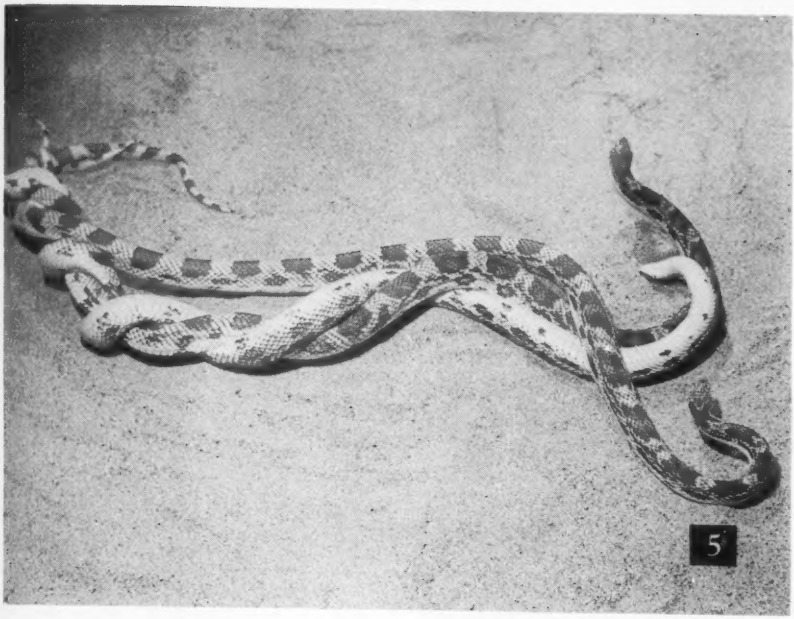
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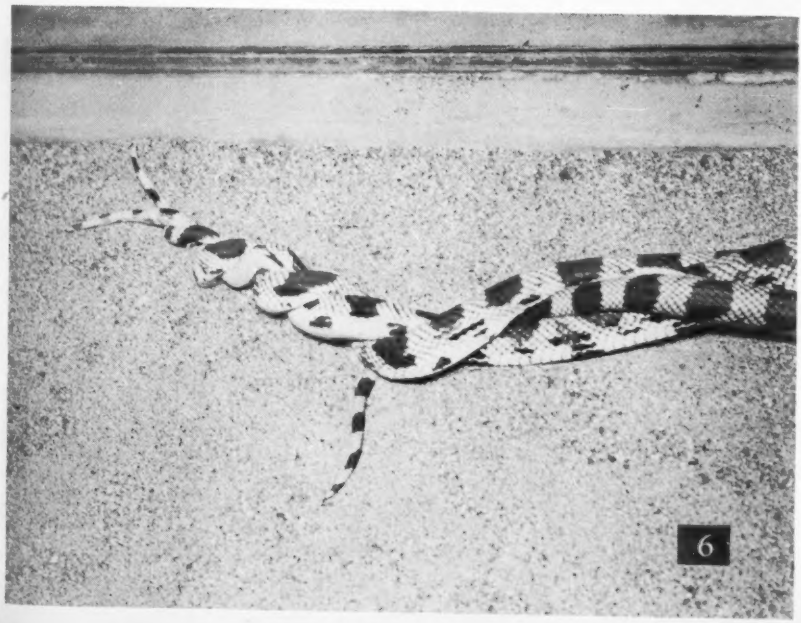
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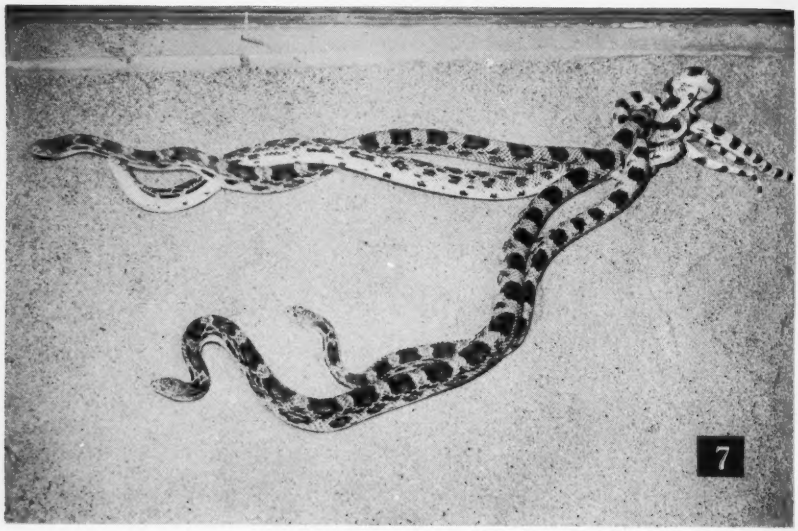
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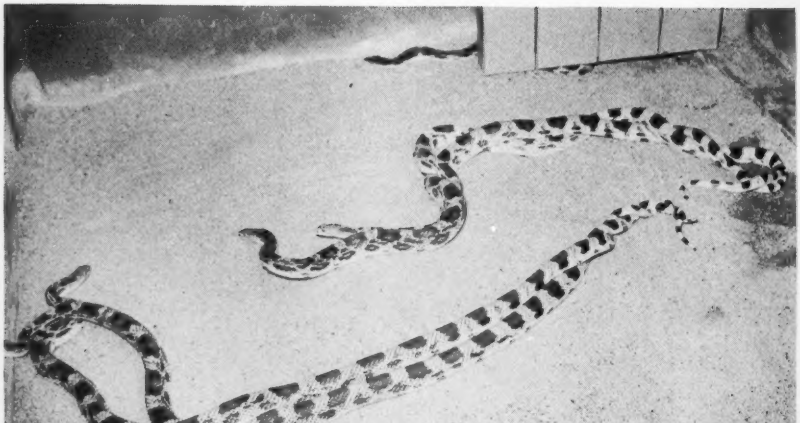
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by lifting the anterior portion of his own body up and over that of his opponent. This action is continuous, each loop so formed passing posteriorly down the bodies of both snakes until sometimes about half the length of the snakes is entwined (fig. 4). The twining is tightest on the posterior of the bodies and looser farther forward. During this action both snakes softly hiss at frequent but irregular intervals. While entwined both males appear to struggle to tighten the loops each has about the other's body and such twisting together causes a squeaking sound similar to that produced by two pieces of leather rubbed or twisted together; the sound thus produced is audible at a distance of five or six feet. As in the crotalid "combat dance" one of the males may "throw" his opponent (figs. 5 and 7) although just how this act is accomplished, and whether a particular one or both snakes may participate has not been determined due to the close entwining of the bodies and the speed of the action. Although initially the neck-twining and the twisting together of the bodies of both males is fairly rapid until about one-half their length is entwined, this action eventually slows to the point where only an occasional looping of necks is made. The addition of further loops at infrequent intervals apparently serves to keep the bodies of the males twisted together to about the same degree and compensates for a gradual unwinding taking place posteriorly as a result of lateral movements of the tails of one or both males

Typical courtship motions on the part of the aggressive male toward his opponent are not at all infrequent. Such actions may take place either before twining has begun or after it is well underway or both. These movements are termed "typical courtship motions" since they appear to differ in no obvious respect from the courting overtures a male makes toward a female. The muscular rippling movements of the ventrum and lower sides of the body or the horizonal twitching movements of the aggressive male's tail, or both, are commonly observed during combat between two males. Also, occasionally one male may undulate the free anterior portion of his body over that of the other male. A single instance has been observed in which a male at the height of his excitement lifted the tail of his opponent off the floor of the cage with his own in what appeared to be an attempt to bring the cloacae together. At no time has any swelling of the cloacal region or partial eversion of a hemipenis been noted in the aggressive male. However, the tails of both males are usually so closely twined together (fig. 6) that such actions probably could not be seen even if taking place.

On one occasion a male was observed to have a secure biting grip on the back of the head and neck of another male. This grip had lasted at least one hour when the observations had to be terminated. The bodies of the two males were not twined together. None of the courtship motions were evident in this case, but the neck grip itself may be assumed to have been a courtship gesture of the one male toward the other since it has been interpreted by Noble (1937) as constituting a stimulation of the female during courtship. It is not known whether a "combat dance" had preceded this position on the part of the two males. It is, of course, obvious that a typical "combat dance" could not take place if one male were biting the other since the necks could not then be twined.

More often than not, interference with a courting male and female by another male meets no opposition or notice from the courting male. When several males are courting a single female with the resultant confusion on the part of the males as to just which snake is male and which female, a male may be courted by another male. The persistent rubbing of

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the courting male's body over that of another male usually leads the courted male to respond by nudging or attempting to throw off the male that is bothering him. Frequently when all four males are piled up after one female, such nudging by one of the males leads to a gradual build up of nudging by all males involved and this behavior may slowly evolve into combat in which two, three or all four males may participate (figs. 7 and 8). Rarely a male may be thoroughly courted by another male without paying the slightest attention to the courting male's activities.

A male in copulation pays no attention to the interference of other males. On January 3, 1947 a male was noted courting a female at 8:55 a.m. At 9:04 a.m. the pair was in copulation, the male having a secure biting grip on the back of the head and neck of the female. The other 3 adult males were all mixed up in a pile with the breeding pair. The copulating male successfully pursued his courtship and copulation without paying any attention to the other males or attempting to engage them in combat.

Pituophis m. annectens

On June 16, 1950, 3 adult males and one adult female *P. m. annectens* confined in the same cage were fed full-grown mice. Shortly after all snakes had finished feeding, one of the males began to act in an aggressive manner, biting on any part of the body of any other snake that happened near him. The male finally chose a somewhat shorter male than himself and confined the rest of his activities to this one individual, ignoring the other snakes in the cage. The aggressive male bit the other male several times at mid-body as well as on the neck and head in what seemed an attempt to eat him. The biting of the aggressive male did not appear to be done in anger, rather it was preceded by a seemingly deliberate study of his victim, much as in the manner of a snake looking over a mouse or rat about to be eaten, in an attempt to determine the best point from which to seize it. The smaller male several times retaliated by biting the aggressive male. The biting holds of the aggressive male were of very brief duration except for two occasions when the jaws of both snakes became interlocked and they had to be separated from one another. Presumably mouse odors on the aggressive male's principal opponent, as well as the other snakes that were bitten, led the aggressive male to do the biting. At any rate the points bitten by the aggressor appeared to be carefully chosen and the biting was done with deliberation rather than in a rapid and random fashion as might be expected had the snake been biting in anger. Both males crawled about the cage floor and frequently maneuvered into a position in which the somewhat larger and aggressive male was draped in a more or less undulate fashion over the other male's body, and both were crawling in the same direction. With much nudging the smaller male attempted to throw the larger male off his back. Both males shortly assumed the combat stance, with neck flexed as if to strike. The "dance" then began with the same crossing over of heads and necks as has been described above for *P. m. melanoleucus*. In the case of the *annectens*, however, no courtship motions were observed. In all probability the events leading up to the "dance" were not initiated by the sexual desires of the larger and aggressive male, but rather excitement caused by feeding and his attempt to find more food. The subsequent combat of both males may, however, have been brought about by a sexual stimulation of the aggressor in his maneuverings with the other male. On August 10, 1951, this same behavior was repeated.

On April 12, 1951, a small male *P. m. annectens* about 42 inches in length was vigorously courting a larger male about 53 inches long. The

smaller male did not attempt to secure a biting hold on the neck of the larger male, but otherwise made the usual courtship motions consisting of muscular rippling in the ventrum and lower sides of the body, undulations over the back of the larger male and the side-to-side tail twitching over the tail of the other male. The smaller male crawled forward over the back of the larger male while courting and on two occasions, when the smaller male's head appeared sufficiently far forward on the back of the larger male, the courted male responded to the courting overtures by assuming a combat stance, that is with head and neck flexed. The larger male could not loop his head and neck about that of the courting male evidently because the latter was shorter and his head and neck did not reach far enough forward on the back of the larger male. The larger male appeared unable to follow through with a normal combat "dance" because the smaller male maintained a normal courtship juxtaposition of his tail with that of the larger snake. The larger male also showed his apparent annoyance by frequently trying to nudge off the smaller male but not violently enough to cause him to completely lose his position.

Perhaps as a result of being stimulated by the courting activities of the small male, the larger male also made courting motions consisting of muscular rippling in the ventro-lateral surfaces and also tail twitching. No part of the larger male's body was overlying that of the smaller male at this time, however. Neither male bit the other during this behavior. These two males had been caged together in the absence of females since October 28, 1946.

Elaphe g. guttata

On three occasions males of the corn snake have been observed in combat. In all instances the "dances" followed immediately after the snakes were fed. The second instance of combat in these snakes occurred during a period of some sexual activity in the cage, the aggressive male having courted a male much smaller than himself several days prior to the combat observed. Combat did not involve this small male which had never responded to the courting of the larger male except to coil rather tightly and remain in that position. The male which courted the small male was observed however, to engage a male larger than himself in combat following feeding. As in the case of the *P. m. annectens* described in combat after feeding, there were no courtship motions observed during the "dance." The corn snakes did not bite one another prior to or during combat, but there seems to be no doubt that the behavior was brought about by a search for more food as in the case of the *P. m. annectens*. The excitement caused by feeding and subsequent investigatory wanderings about the cage of these snakes and their interest in any movement on the part of the other males led to combat in each case. A peculiarity of behavior in such excited males of *E. g. guttata* is the nervous, short, forward jerking movements of one or both males when one is contacted or even approached by another. These movements appear to be similar if not identical to the "spasmodic twitches" described by Noble (1937) for an *Elaphe o. obsoleta* female at the beginning of courtship.

These specimens of *E. g. guttata* have been confined in the same cage for varying lengths of time, from 6 months to 13 years, but no females have ever been in the cage with them.

Lampropeltis d. annulata

Two males of this snake, confined together in the absence of females since September 8, 1940, have been noted in a combat "dance" on three occasions in the spring of 1951. In all instances the combat behavior followed immediately after the snakes had been

fed or while one of them was still feeding. In the first two "dances" witnessed there was no biting of one male by another, nor were any courtship motions observed; combat behavior appeared to be caused by a search for additional food on the part of the aggressive male. The second case of combat witnessed in these snakes lasted about 15 minutes and was terminated by the non-aggressive male which fled from the aggressor. The non-aggressive male was repeatedly re-approached by the aggressive male but steadfastly refused to be re-engaged in combat. A short while later the aggressive male suddenly spied the movements of his own tail and immediately seized it and succeeded in swallowing two or three inches of it before finally letting go. On April 30, 1951, while being fed, these snakes were observed in combat for a third time this spring. The somewhat larger male had already finished feeding, but the smaller male still was holding his mouse by the head. The larger male was crawling over the smaller male's back and was being nudged in an attempt by the smaller male to rid himself of this annoyance. Both snakes had flexed their necks and were following through with the usual twisting of their bodies. The larger male was making what appeared to be courting motions over the back of the smaller male, jerky undulations of his body with his chin pressed firmly against the back of the smaller male. The larger male showed no interest in attempting to eat the mouse the smaller male was still holding in his mouth. The aggressive male bit the smaller male twice during the observations, but whether such biting represented an attempt to secure the neck or head-biting hold of the courtship pattern is unknown. On two occasions the smaller male made four or five typical constricting loops about the body of the larger male; these were not the "twisted rope" loops of combat behavior. These activities were observed for about 30 minutes and were terminated when the smaller male finally released his hold on the mouse and fled from the larger male. The aggressive male showed no interest in the mouse that had been released by the other snake.

The combat stance observed in *L. d. annulata* is identical with that noted in *Pituophis* and *Elaphe*. The only observed difference in *Lampropeltis* is a much faster neck twining action.

Combat in other American Colubrids

Hansen (1950) has recorded an interesting case of behavior in two male *P. m. deserticola* in the field at Ibapah, Toole County, Utah. A 40 inch male was observed holding with his mouth a 35 inch male. "The smaller snake was vigorously thrashing its body back and forth in an effort to escape while the larger one was throwing body loops over it in an effort to make it hold still." The bodies are described as being free except for the neck hold of the larger snake and the four or five tight twists anterior to their cloacal region. The activities observed were interpreted by Hansen as attempted copulation, an interpretation that appears correct since the larger male was observed to try to bring his cloaca in contact with that of the smaller male. Such action by the large male caused the smaller male to break away in an attempt to escape, but the smaller male was "rapidly followed by the larger male which grasped the fleeing individual near the middle of the body and stopped his flight. By successively quieting the smaller snake and grasping him farther forward he worked his hold up to the neck, whereupon the looping and entwining of the bodies was started again."

This behavior differs markedly from the combat behavior observed in captive *Pituophis, Elaphe,* and *Lampropeltis*. It appears that the body twisting was similar to that noted in the above mentioned genera, yet the

manner in which the twining together of the bodies was achieved is completely different. From our own observations such body twisting is clearly a fundamentally characteristic performance resulting from the stereotyped combat stance and looping over of flexed necks and it would be impossible for a "dance" to occur if one male had a biting grip on the neck of the other. It is astonishing that *P. m. deserticola* should appear to differ from *P. m. melanoleucus* and *P. m. annectens* in the method by which the bodies are twined together.

Woodbury (1941) has also recorded a case of combat behavior in *P. m. deserticola* as observed by Miss M. Barrie Berryman and Miss Lucile Olson. Three snakes were involved in these observations, reputedly a female and two males although the sexes were not definitely determined either by dissection, eversion of hemipenes or other satisfactory means. The assumed female is reported to have been passive during the behavior of the males which seem to have been overlying the female, although the position of the males with reference to the female is not made completely clear. From this account it may be presumed that the two males had been courting the female and then had become involved with one another in combat, the larger male having become confused and substituted the smaller male for the female in his courtship activities. Similar behavior in which two males originally courting a female, become confused and court one another, has been observed frequently in *P. m. melanoleucus* and usually leads to combat between the two males.

Tinkle (1951) has reported a mating "dance" between a presumed female *Drymarchon corais melanurus* and a male *Drymarchon c. couperi*. The "female," newly acquired for the collection of the Audubon Park Zoo in New Orleans, was placed in the cage with the male which had been in the collection a number of months. Subsequent activities following the initial aggressive behavior of the male, involved combat, with neck twining, between both snakes, biting of each snake by the other and also what were evidently courtship actions, each snake making courting overtures to the other on several occasions.

To what extent the feeding response figured in initiating the behavior of the aggressive snake and the defensive response of the other snake cannot, of course, be determined. But the fact remains that *Drymarchon* is ophiophagous in habit and that hunger (or fear of being eaten) may have been an important factor in the behavior of these two snakes aside from the apparent sexual readiness of both individuals.

Combat in Old World Colubrids and Elapids

Millett (1909), Beadon (1910) and Wall (1921) have recorded combat behavior in the snake now known as *Ptyas mucosus*. The interpretation offered by these authors for this behavior at the time of their various writings was that it was part of the courtship behavior normal to the species. It remained for McCann (1935) actually to dissect two specimens that had been so engaged and determine the sex of each as male.

Basically identical behavior during combat between males of *Ptyas mucosus* has been reported by each of these authors, and that of Wall (1921) quoting the observation of a Major Frere states: "They were surrounded by thick felled scrub so I had to kill them, being unable to take them alive. The ventral aspect of their anal shields appeared to be closely approximated. Their bodies were twined together and writhing except for the anterior quarter. Their heads were raised from the ground for 1 foot to 18 inches and appeared to be sparring at each other like two young cockerels. Their movements were active and vigorous."

Stemmler-Morath (1935) has also reported combat (interpreted by him as courtship between male and female) of four European colubrids, viz. *Coluber gemonensis, Malpolon m. monspessulanus, M. m. insignitus* and *Elaphe l. longissima.* A translation of the description of this behavior is given by Davis (1936). In quoting this Davis ascribes the description to *Coluber gemonensis* while in reality it is that of *Elaphe l. longissima.* The translated description as given by Davis follows: "A pair of splendid aesculapian snakes crawl quietly one behind the other. The rear animal, obviously the male, tongues the body of the crawling female almost continually. She gradually begins to move more rapidly, but the more rapidly the female glides along, the more actively the male follows. Finally the two long bodies of both snakes dash along, one behind the other, almost completely extended. There is no longer any of the close application of the body to the terrain in crawling which we are accustomed to see in these snakes. The two animals hasten with uncanny speed through the area, over rocks and ponds, often up into the bushes and down again over the outermost twigs. This chase lasts until the male succeeds in reaching the side of the female. He at once throws his neck around the body of the female with lightning speed and draws up his body, coiling around her in several turns while crawling forward on the body of the female. The entwined pair continues to move about the area, and for a quarter of an hour or more they crawl through each other's coils uninterruptedly, so that first one and then the other is above. The heads are now carried always at the same height. Suddenly one of the animals raises its front end until the anterior third of the body, freed from its partner, stands almost vertically. The other animal does likewise, and now the heads are placed quite near each other and obliquely depressed forward. The upraised anterior parts of the body, well separated from each other, with only the posterior two-thirds of the bodies twined together like wire, resemble a lyre. But not only do they exhibit this handsome shape when at rest; they often dash through the terrarium in this attitude. In spite of the fact that they continually change their relative positions by their constant crawling around each other, they carefully preserve the character of the figure. Although these dances often last more than an hour, I was never successful in photographing it. The final union then usually takes place under a bush, a rock or a tree, so that one rarely is able to see it. The male always bites fast on the neck of the female."

From this description, the method of twisting the bodies together appears somewhat similar in the European and American colubrids, since the aggressive male is described as throwing his neck about the body of the "female." A like response from the other snake is not mentioned.

The vertical, lyre-shaped stance employed by the European snakes is unquestionably the most spectacular colubrid combat behavior pattern yet reported. However, it is difficult to understand precisely how the snakes successfully manage their dashes about the terrarium with the anterior one-third of their bodies raised from the ground and the posterior two-thirds twisted together.

Combat between male elapids is known only in the Australian *Pseudechis porphyriacus* and *Demansia textilis.* Regarding *Pseudechis* Fleay (1937) states: "as the day became warmer, two of the largest snakes approached one another and moved along side by side with heads arched and raised about a foot from the ground." Again Fleay (1951) remarks concerning *Pseudechis*: Plaited together like thick ropes, as they were, it was the continually swaying heads and necks

of these heavy-bodied fellows, raised at least a foot above the ground, that could be plainly seen from a distance of fifty yards." Observations of combatant male *Pseudechis porphyriacus* at the San Diego Zoo agree essentially with Fleay's description of this behavior. In reporting male combat in the Brown Snake (*Demansia textilis*) Fleay (1951) says: "The rope plaiting grip of the rivals about one another was even more severe than in the case of the Black Snake, and a greater length of the fore part of the body remained free and upstanding as the reptiles sparred for the grip that precipitated the writhing, rolling and gasping of strenuous combat."

The combat stance of the above mentioned colubrids and elapids appears to differ strikingly from the combat stance of the North American colubrids. The divergence lies in the vertical erection of more or less of the anterior part of the body in these Old World snakes and the retention of a horizontal position throughout the "dance" in the American snakes. The vertical stance reported for the Old World snakes is similar to, although perhaps not so extreme in most instances (excepting in the case of the colubrids reported by Stemmler-Morath) as that of the crotalids and viperids which raise approximately the anterior one-third of the body when fighting. In this connection the paucity of field records of combat behavior between males of American colubrids may perhaps be due in some measure to the horizontal position employed throughout the combat, for this position would render them much less conspicuous and more difficult of observation than would the vertical position employed by the crotalids for example. No doubt such a horizontal position would also be more likely to be mistaken as normal courtship behavior, or copulation, and under this guise the true identities of the participants would be concealed.

Combat behavior between male *Coluber** or *Masticophis* has not as yet been reported in this country; it is possible that a vertical stance during at least some stage of combat may be found in members of these genera thus paralleling that observed in European *Coluber*. Identical combat behavior apparently does not exist in the genus *Elaphe*, at least our observations show that the stance assumed by *E. g. guttata* is a horizontal one throughout the performance in contrast to the vertical stance described by Stemmler-Morath (1935) for *Elaphe l. longissima*.

The Function of the "Combat Dance"

Lowe (1948), following the example of McCann (1935) and Fleay (1937) has interpreted male combat behavior of snakes as a manifestation of territoriality. Such an interpretation has recently been reiterated by Smith (1951) who also states with reference to fighting in lizards: "Fighting is common among the males, the two combatants seizing one another by the head or body and biting and struggling until finally one is exhausted and gives in. This type of behavior, with rivalry and combat, is fairly general among the lizards, but as far as is known is rare in snakes." This rarity of combat between male snakes as contrasted with its prevalence in lizards gives evidence in itself against the belief that male combat behavior in snakes results from territoriality. Smith's conviction that male combat is an expression of territorial rivalry is difficult to reconcile with the observations quoted on pages 250 and 251 of his recent book.

Lowe and Norris (1950) have revised Lowe's earlier opinion of the meaning of combat behavior between the males of some snakes, but they

* Excepting possibly *Coluber constrictor mormon*. See page 165.

point out that aggressive behavior associated with the defense of an area (but not male combat) has been observed in the elapid genera *Naja, Ophiophagus* and *Dendroaspis*. These same authors state: "From a study of the cases reported thus far, it is recognized that in snakes, as in lizards, aggressive behavior is an expression of competition involving, as the case may be, territoriality, and social or sexual domination; it may also be involved in sex discrimination and in the testing of sexual readiness."

To my knowledge social or sexual domination has not been demonstrated for any ophidian. Sex discrimination as an explanation of male combat behavior appears untenable due to the length of time during which males may be involved in combat. As far as our observations are concerned sex discrimination should be immediate since initially an aggressive colubrid male usually encounters considerable "nudging" from the male object of his attentions, and finally combat with a characteristic posture and movements should the aggressor persist in forcing his attentions on the other male. That there is an evident complete lack of sex discrimination seems apparent from the numerous instances in which male specimens of *P. m. melanoleucus* have made courtship overtures to their opponents while in combat. In addition Noble (1937) has shown that sex recognition is accomplished chiefly by chemical sense in the snakes which he has investigated experimentally. By inference from Noble's results the same method of sex discrimination is generally extended to all ophidians.

Although comparatively little is known of the breeding habits of snakes in general sexual readiness of females throughout the group is presumably signaled by distinctive body skin odors Noble (1937) remarks: "garter snakes appear to experience an oestrous cycle in that courting males return on successive days to the same female while ignoring females which seem identical in size and color to the selected one." As a test of sexual readiness therefore, combat between two males can have no meaning since it should not be possible for a male to attract another male by means of a chemical stimulus in the form of a distinctive body odor.

From observations of captive colubrids at the San Diego Zoo it is evident that combat behavior may result from at least two apparently distinct situations in which males alone are involved. The first of these plainly occurs only during the breeding season as in the case of *P. m. melanoleucus* and appears to be, insofar as those numerous cases in which courtship motions have been concerned, a result of homosexual behavior of an aggressive male toward another male. The other situation involves typical combat behavior on the part of males after or during feeding. To what extent the sexual condition of the participating males figures in combat under the latter circumstances is unknown; but most of these instances have taken place during the spring or early summer and therefore presumably during the breeding season. At any rate, the excitement engendered during feeding appears to lead an aggressive male to pursue another male, and the resulting combat is identical with that performed during the definitely recognizable breeding period of *P. m. melanoleucus* when the males are unmistakably sexually excited. In only a single instance (*L. d. annulata*) have evident courtship motions been observed in the aggressive male during combat following feeding.

It is difficult to account for the apparent failure of the chemical cues for sex recognition in those snakes in which courtship motions have been observed in the aggressive male while in combat. Although there is no experimental evidence bearing directly on the genera concerned here (*Pituophis, Elaphe, Lampropeltis*) presumably sex recognition is accomplished,

as Noble (1937) has shown for *Storeria* and *Thamnophis* by a "chemical sense, both olfactory and Jacobson's organs playing a part. Males distinguish the skins of their companions by their odor, both species and sex differences being recognized." The same author states: "Movement plays an important role during courtship. An etherized or freshly killed female *Thamnophis* is not sexually attractive." Here may possibly lie the clue to the apparent sexual deviation of *P. m. melanoleucus,* for example. As our observations of this snake have revealed, it is characteristic for the females to lie passively coiled almost entirely throughout the period of sexual activity; males contrariwise are vigorously active and the movements of one male frequently attract another. It is at this point that sex recognition in the chemical sense evidently fails, for the aggressive male that has been attracted by a moving male very obviously does not heed any possible information imparted by olfaction or Jacobson's organs concerning the sex of the object of his interest. Movement of the one male appears to override and dominate the chemical senses in the sexually excited aggressive male.

Of interest in connection with homosexual behavior as the cause of male combat during the breeding season are the following observations of Lederer (1931) (translation): "In 1927 we received with a direct importation from California 2 water moccasins (*Ancistrodon piscivorus* Lac.) which quickly got used to our reptile division. In the spring of 1930 we often watched the snakes in amorous play which, for the most part, progressed very stormily. We could sometimes see the larger male seize the nape of the neck of the smaller supposed female in his jaws in the same manner as lizards, but the poison fangs were never used. The surprising thing in this courtship was that always at the last moment the "female" tried to avoid the male. One morning about 10 o'clock, the courting male accomplished the pairing whereupon both animals acted as if possessed. As the animals were still together after six hours we began to ponder. In spite of their exertions the animals could not get apart. The tie was finally broken about half past seven in the evening. Some time afterward we noted that the male that ate well became fatter while the female took no more nourishment. 66 days after pairing the female died. The dissection gave the suprising result that it was not a female but a male."

The description of the courtship of these two male *Agkistrodon* leaves much to be desired in the way of detail. However, one may hazard the guess that the stormy courtship probably was male combat of the crotalid type, since the customary passive behavior of female crotalids during normal courtship could hardly be described as stormy.

Davis' (1936) report on the observations of R. Marlin Perkins concerning a "courtship dance" in *Agkistrodon piscivorus* may also be of some significance in the interpretation of male combat as resulting from homosexuality. Regarding the "dance" of the water moccasins that Perkins had observed Davis states: "This extraordinary behavior may continue for hours at a time, and is usually followed by copulation." I have stated elsewhere (Shaw, 1948) that such copulation may have been of a homosexual nature, but more probably in this particular case a normal mating in which the female had been confused by the observer with a previously observed combatant male.

Dr. Charles H. Lowe, Jr. has kindly called my attention to a note by Cottam (1937) who witnessed copulation in a pair of *Coluber constrictor mormon* at Moab, Grand Co., Utah. There seems to be a possibility that this was a homosexual union, but in neither of the snakes was sex accurately determined. Of course, the nat-

ural assumption of the observer would be that since the snakes were copulating they would be male and female. That a "combat dance" may perhaps have occurred is suggested in the following remark: "When first observed the snakes were twined one about the other, but the number of coils increased as they moved off. Their path was tortuous and their motion spiral in nature, due to their independent efforts in attempting to travel under this handicap."

Noble (1937) has observed homosexual courtship of male *Thamnophis sirtalis*. In both instances the males involved were from widely separated localities. This fact is believed by Noble to be significant, possibly the snakes in the population from which the courted male was taken having evolved odors nearly like the females from the area in which the males showing the homosexual behavior were taken. Combat between these male *Thamnophis* did not result, and such behavior in sexually excited males of this genus, even when two pursue the same female, is unknown.

The probability that homosexual behavior of one male towards another results in male combat in snakes might appear to indicate that sex discrimination is directly involved. Regarding homosexuality in lizards, Noble and Bradley (1933) state: "It has been shown above that lizards of several families, when kept in good health in large laboratory cages, court and frequently copulate with other males. Since the cloaca of a male lizard permits the insertion of the hemipenis of another male, these is no structural hinderance to this performance. The only mechanism which is present to prevent males copulating with other males as frequently as with females is that males when meeting each other during the breeding season tend to fight. The result is that males tend to occupy discrete territories, which are difficult to recognize in the laboratory but which have been described in the field."

That the method of sex recognition in lizards, a fighting response of a male toward another, does not seem applicable in the case of combatant male snakes has been stated above. The length of time during which two antagonists remain in combat would seem to rule out the idea that male combat involves sex recognition. As pointed out by Smith (1951), combat in male lizards is a relatively commonplace event, while it is somewhat of a rarity in snakes, thus indicating that the same behavior in the two groups does not necessarily have the same territorial basis.

Obviously a great deal of careful observation and experimentation is needed before an attempt can be made to determine beyond doubt the true meaning of combat behavior in male snakes. Observers of such behavior should be positive that their identifications of sex are made *accurately*, either by means of eversion of the hemipenes or dissection. Courtship should be distinguished from combat behavior, and in cases of male combat, courtship overtures should be watched for both during the "dance" and in the events leading up to actual combat. It also would seem important that in cases of actual mating, both in the field and captivity, the sex of each snake should be determined beyond question, for there is a possibility that homosexual unions may be of much more frequent occurrence than has hitherto been supposed.

Summary

As in all snakes in which both combat and courtship behavior have been observed, courtship behavior in *Pituophis m. melanoleucus* contrasts sharply with combat behavior. A female that passively submits to courtship exhibits none of the behavior pattern evident in combat between two males. A female that does not desire to be courted or otherwise objects to the attentions of a male shows none of the

behavior pattern of combat between two males.

Combat or a "dance" between males of *Pituophis m. melanoleucus, P. m. annectens, Elaphe g. guttata* and *Lampropeltis d. annulata* has been observed in captive specimens at the San Diego Zoo. Combat between males of these snakes occurred during a definitely recognizable period of breeding activity or during or immediately after feeding. The majority of instances of combat under the latter circumstances have taken place during the spring and early summer. Presumably such "dances" also occurred during a period of breeding activity and have their genesis in the sexual state of the males involved.

Courtship motions of an aggressive male toward his opponent while both are in combat have been observed in *P. m. melanoleucus* and *L. d. annulata.* In the instances of combat here reported it is believed that excitement engendered by other moving males, both during the breeding season and during or after feeding, leads to contact between males and subsequent combat. The apparent failure of chemical means of sex discrimination during the period of sexual activity of captive *P. m. melanoleucus* and the resulting courtship of one male by another while in combat, appear to be the effect of subjugation of the chemical senses by an object made attractive by its motion.

At least two differing stances are employed by colubrid males in combat. A horizontal position is maintained throughout the "dance" in the American colubrids described in this paper. In contrast, in the cases reported thus far, a vertical stance occurs during combat between Old World colubrids. The spectacular behavior of European colubrids rivals that of the crotalids and viperids.

An instance of homosexual mating in *Agkistrodon piscivorus* that seems to have been preceded by combat between the two males has been reported.

Homosexual behavior has been described for *Thamnophis.* No combat behavior has been noted in any of the natricine snakes, however. This suggests that either the chemical senses are better developed in the natricine snakes or that the role of movement in courtship is of secondary importance in these snakes as contrasted with other colubrids.

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On the Recognition of Two Lower California Horned Lizards

By Ernest R. Tinkham

In May, 1947, as the result of an attempt to treat with the Horned Lizards of the North American Deserts in his desert book entitled, "Life of the North American Deserts," the writer undertook a revision of the Lower Californian species of the genus *Phrynosoma.*

It seems appropriate to publish now as a foreword, notes on two species which at the present moment are considered synonyms. The author's studies have shown that three distinct groups are at present included in the so-called "Coronatum Group" of other herpetologists. A complete account of these groups will be published later.

The two species that require recognition at the present moment are members of the same group, the Blainvillii Group of the genus *Phrynosoma.*

Diagnostic Features of the Blainvillii Group: Size medium-large to large, nostrils of average size, circumnasals usually small and linear. Profile of the head receding in almost a straight line from the snout to the dorsum of the head. Lateral temporal horns all directed posterioradly, the two most caudad in position, the posterior lateral and the posterior temporal, usually touching or closely grouped with their axes parallel or subparallel and directed well to the rear, these horns straight or with slight curvature to the rear. Head scales small, flat, granular to rugosely ridged or convexly polished. Interparietal, small, ovate or sagittate, much longer than broad. Post-cephalic tubercles, the transverse row of tubercles just caudad of the posterior margin of the dorsum of the head, almost always four in number, very rarely five. Interoccipital small and separated from the internal base of the occipitals. Postrictal always present. Chin shields always five in number. Gulars in four to five paired rows observed in central position with often a minute median row.

Phrynosoma schmidti Barbour

1921. *Phrynosoma schmidti* Barbour Proc. New England Zool. Club, 7: 113-115 (desc.).

1922. *Phrynosoma cerroense* Van Denburgh. Calif. Acad. Sci., vol. 1, p. 401 (synonymy).

1922. *Phrynosoma schmidti* Schmidt. Bull. Amer. Mus. Nat. Hist., 46(11): 668 (Listed only).

1936. *Phrynosoma blainvillii frontale* Klauber. Copeia, No. 2, p. 110 (synonymy).

1943. *Phrynosoma schmidti* Stejneger and Barbour. Bull. Mus. Comp. Zool., 93(1): 95 (check list).

1945. *Phrynosoma schmidti* Ditmars. Doubleday, Doran and Co., p. 71 (description).

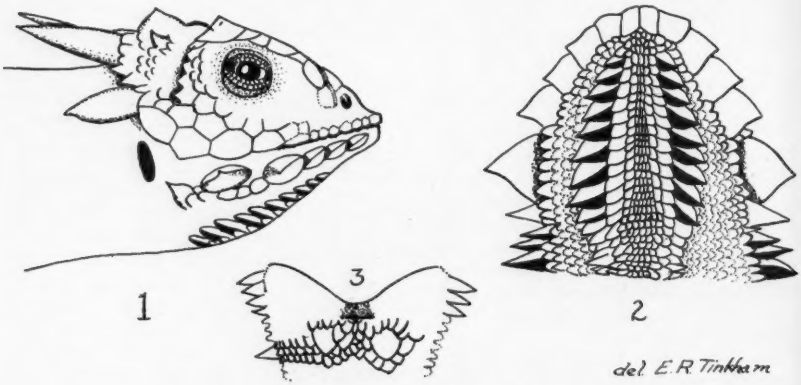
Schmidt's Horned Lizard is a well-defined insular species of the Blainvillii Group. Van Denburgh (1922) considered this species identical with *P. cerroense* Stejneger, but apparently gave little study to the two Cerros Island Horned Lizards, so amply distinct in many ways. Klauber (1936) placed *P. schmidti* as a synonym of *P. b. frontale* with some reserve, noting in particular the character of the occipitals lying flat along the body as the "most consistent differential character of *schmidti.*" There are a number of other important characters found in the very small young as well as the adults and these seem to warrant recognition on *schmidti* as a race, if not a full species as indicated here.

Diagnostic characteristics: A medium sized species with the inner pair of postcephalic tubercles greatly enlarged and prominent and when

viewed in profile appearing on a level with the dorsum of the head (see figure 1.). Occipitals slightly divergent with their long axes lying parallel or flat with the dorsum of the head. Chin shields five in number, the first or anterior pair unusually large and approximating in size the second pair, the first pair much larger than in all other species of the genus (see figure 2.). This character holds for the very small young as well as the adults. Dorsal lepidosis well developed, with diamond-shaped keeled scales. Ventral row of body fringes well developed. Post-anal scales of male with two large outer scales and the intervening intermediates quite small, these intermediates smaller than in any other species of Lower Californian Horned Lizards (see figure 3.).

Specimens Examined: Two of the original paratypes have been examined through the courtesy of Mr. Arthur Loveridge of the Museum of Comparative Zoology at Harvard. They are MCZ No. 15144 a mature male and MCZ No. 15145, a very small young female. Measurements for 15144 are: total length 88.0 mms., body length 57.0, tail 31.0, breadth of head 11.2, snout to tip of occipitals 22.0, snout to postcephalic tubercles 14.5, snout to cephalic spine 11.5 mms.

Young: MCZ No. 151455, a very small female with the same data as the paratype male. Total length 31.0 mms., snout to vent 24.0 mms. First and second pairs of chin shields large and closely similar in size. Outer row of gulars about twice the size of the next interad row. Inferior peripheral fringe well developed. Head with the postcephalic boss or prominence convex, with the scales of the interparietal and the inner pair of postcephalic tubercles represented as very large scales lacking any tuberosity. Lepidosis of the back prominent. Occipitals widely separated with the interoccipital represented as a broad triangulate scale. It is thus observed that the characters distinguishing *P. schmidti*



Explanation of Figures: 1. Enlarged view of head of male paratype No MCV:15144 in profile. 2. Ventral view of head of male paratype of *Phrynosoma schmidti* Barbour, showing characteristic chin shields and gulars. 3. Sketch of the post-anal scales in the male paratype.

in the adult are also indicative of the very small young and further supports the evidence that *schmidti* is a valid species.

The original type series, the type MCZ No. 15142 and three paratypes MCZ Nos. 15143-5, were collected by Mr. W. W. Brown on the John E. Thayer expedition to Lower California. No mention of the date of collection or of the time of the expedition is given in the original description. Mr. Thomas Barbour named this Cerros Island horned lizard after the well-known herpetologist, Karl Patterson Schmidt, whose later work (1922) is the finest report to date on the herpetofauna of Lower California.

Phrynosoma blainvillii nelsoni Schmidt

1922. *Phrynosoma nelsoni* Schmidt. Bull. Amer. Mus. Nat. Hist., 46(11): 668-9, pls. LV, LVI. (desc.).

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1945. *Phrynosoma nelsoni* Ditmars. Reptiles of North America, Doubleday, Doran & Co., p. 72 (desc.).

1946. *Phrynosoma coronatum frontale* Smith. Handbook of Lizards, Comstock Publ. Co., pp. 295-7, pl. 76 (biology, etc.).

Diagnostic Characteristics: Coloration decidedly reddish. Head with dorsal scales small, quite regular with rugose granules often ridged centrally and quite distinct from the rounded granule appearance of *frontale*. Posterior temporals and occipitals well developed and ridged dorsally, with specimens from the San Quintin Bay area, Laguna Seca Chapalla and the Sierra de San Borjas east of Punta Prieta, developing longer horns than those from Colorado Desert sections of El Marmol to Punta Prieta, and San Augustine, where the horns are shorter and broader. Interoccipital a short broadly triangulate tubercle. Postcephalic tubercles almost always four and usually more prominently developed than in *frontale*; those from the type locality, San Quintin, with high acute tubercles. Suboculars and postocular scales more prominently developed than in *blainvillii* and more so than in *frontale*. Anterior portions of the lower jaw usually more elliptically rounded than in *frontale*, where it is more ovally rounded, except in those from San Joaquin Valley. Gulars, centrally, in five paired rows or five paired rows plus median row or rarely six paired rows as compared to usually less than five paired rows in *frontale*. Central rows of belly with usually 25-27, sometimes 24 in the male and 22-25 in the *nelsoni* female, and usually 22-24, sometimes 18-19 or 25-26 in *frontale* males and 21-23 in *frontale* females. Belly and posterior interaxillary scales usually smaller than observed in *frontale*.

Lepidosis: Large scales of back broader and shorter and generally flatter and fewer than the semi-erect scales of *frontale* and *blainvillii*, with the keel low, level and only slightly recurved apically. Large dorsal scales of *frontale* and *blainvillii* are sharply pointed with the tip of the keel projecting apically. Very rarely, long-horned individuals of *nelsoni* from the San Quintin area have a lepidosis resembling *blainvillii* and *frontale*. The lepidosis of *nelsoni* specimens from the Colorado Desert areas of San Augustine and El Marmol south to Punta Prieta quite uniformly portray broad and short, rounded dorsal scales that lie flat with low level keels. Inferior body fringe less developed than in *blainvillii* and *frontale* and in the des-

ert specimens of *nelsoni* almost evanescent. Central or intermediate postanal scales lying between the large lateral ones, larger than in *frontale,* the large laterals smaller than in *frontale,* and with less of a tendency toward fusion to make very large lateral ones. Claws of the forelegs of *nelsoni* females slightly longer and more strongly decurved than in *frontale.*

Specimens Examined: The Type Female, USNM No. 37585, from San Quintin, has been examined, as well as USNM No. 37584, a male. Fifteen specimens from the Museum of Vertebrate Zoology, 15 specimens from the collection of the San Diego Natural History Society, 11 specimens from the Tinkham Collection and 1 from the California Academy of Science have been studied, comprising a total of 44.

P. b. nelsoni ranges from the approximate latitude of San Vincente (31 degrees 25 ' N. Lat.) south to seven miles N. W. of Mesquital where the last Cirios (*Taria columnaria*) are found, thence east to the western base of the Sierra de San Borgas and Sierra Calmalli and in the latitude of Rosario (30 degrees N. Lat.) east to the El Marmol area. Thus, in north central Baja California, it is largely confined to what is here designated as the Cirio Desert, except for the coastal strip of semi-desert chaparral extending north from Rosario to San Vincente. Over this considerable range of the Cirio Desert, *nelsoni* portrays a marked constancy to the southern limits of its desert, showing no intergrading or hybridization with members of the Cerroense Group on the south. An exhaustive treatment of this distinctive subspecies will be presented later in the author's revisionary studies.

P. O. Box 306, Indio, California

SOME NOTES ON A CAPTIVE SCARLET SNAKE.—The manner of burrowing of a scarlet snake (*Cemophora coccinea*) was observed after receipt of an adult of this species on March 28, 1951. Placed in a container with several inches of loose soil, the snake soon began burrowing movements, thrusting the head to right and left until the head and neck were concealed. The procedure then was altered, the snake forcing the snout deeper into the soil and lifting it upward. This continued until the snake was completely concealed. It remained several days in concealment before again emerging.

An anole offered to the snake responded with open mouth and a leap toward the snake as the latter approached. It was eventually eaten.

The snake remains docile and rarely attempts to bite.—V. Wilson, 7154 Alpine Drive, Linden, Michigan.

A RANGE EXTENSION FOR *EUMECES LATICEPS.*—A specimen of *Eumeces laticeps* (Schneider), No. 3705 in the herpetological collection of the Illinois Natural History Survey, was collected by the writer in July of 1940 near Andalusia, Rock Island County, Illinois. The specimen which is immature has a snout-vent length of 64 mm. There are 30 scale rows at midbody. Both sides of the head have eight supra-labials. It is atypical in having one side with one post-labial whereas the other side is typical of *E. fasciatus.* The intercalary scales of the fourth toes extend onto the penultimate phalanx. This specimen extends the known range by 150 miles north of the range indicated by Smith, "Handbook of Lizards."—Robert Craig Schroder, 3424 32nd St., Rock Island, Ill.

The Near Ultraviolet Absorption Spectrum of CROTALUS Venom

By C. W. Horton

The near ultraviolet absorption spectra of two samples of *Crotalus* venom have been measured in an effort to see if the venom can be characterized by this method and if any additional information concerning the chemical structure can be obtained. The writer wishes to express his appreciation of Mr. Laurence M. Klauber in supplying venom samples, to acknowledge the assistance of the Spectrographic Service Department of the University of Texas in measuring the spectra, and to thank Mr. Jack Music for many helpful discussions about the interpretation of the spectra.

Mr. Klauber describes the venom samples as "rattlesnake venom sample No. 435, comprising approximately 1.49 grams of venom removed June 4, 1932, from four diamondbacks, *Crotalus adamanteus*; and No. 470, being 1.45 grams of venom taken November 9, 1932, from five specimens of the western diamond rattler, *Crotalus atrox*."

The dried venom samples were added to a five normal solution of NaOH, and heated for ten hours at 50 degrees C. The resulting solutions were then made up to a strength of 1.20 grams of venom per liter. The ultraviolet absorption spectra were were taken with a Beckman DU Photoelectric Quartz Spectrophotometer. The cells used were quartz and were matched for optical density and path length. Figure 1 contains a graph of the optical density of the solution versus the wavelength in millimicrons. Figure 1 shows that the absorption of the two samples are very similar and that there appears to be little interspecific variation. A promising research program could be undertaken if a representative sequence of venom samples were available.

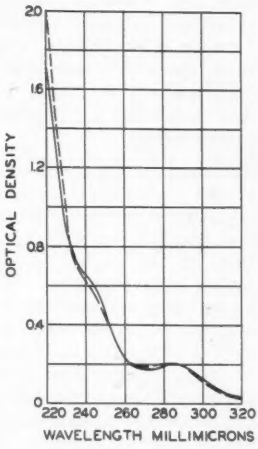

Figure 1. The near ultraviolet absorption spectra of two samples of *Crotalus* venom. The solid curve is *C. atrox* and the dashed curve is *C. adamanteus*.

The absorption spectra have a shoulder at approximately 245 millimicrons and a maximum at about 285 millimicrons. These features suggest at first that the compounds have aromatic structure, i. e., the presence of units in the structure which might be substituted benzenes or other aromatic groups.

However, Slotta and Fraenkel-Conrat (1938: 268) have isolated crotoxin from the venom of *Crotalus t. terrificus* of Brazil, and they report four per cent sulphur and the presence of S-S linkages which they state are broken with NaOH. In view of the fact that the physiological action of the venom of *C. t. terrificus* is so different from that of the North American species (Barbour, 1934: 35), it may appear unjustified to refer to the analysis of Slotta and Fraenkel-

Conrat. However, Wagner-Jauregg (1939: 392) in discussing the biochemical significance of this chemical analysis states that probably both the haemolytic and neurotoxic actions depend on one and the same agent, namely, the enzyme lecithinase. Thus, in considering the interpretation of these absorption spectra, one must keep in mind the possibility of sulphur-containing compounds.

Fehnel and Carmack (1949) have studied the ultraviolet absorption spectra of organic sulphur compounds. They find that these compounds show absorption in the same wavelength region as we have found for the venom samples. It is of interest to note that the absorption spectrum of C2H5-

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SCH2CH2COCH3, a ketosulfide, is very similar to that shown in Figure 1.

The ultraviolet absorption spectra of the venom of two species of rattlesnakes (*Crotalus*) have been measured. The samples were prepared by digesting them in a five normal solution of NaOH. The absorption spectra indicate that either the venom has aromatic structure or the compounds contain sulphur. The latter conclusion is in agreement wth chemical analyses of Slotta and Fraenkel-Conrat (2). More specific conclusions cannot be made unless one determines the molecular weight of the fragments that result from the treatment with NaOH. However, the spectra indicate that significant information regarding the structure of the venom can be obtained from a detailed study of the ultraviolet absorption spectra.

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LAMPROPELTIS CALLIGASTER IN TENNESSEE.—The range of *Lampropeltis calligaster* (Harlan) is incompletely known for Tennessee. Recently the author had the opportunity to examine a live specimen of this snake which was collected May 5, 1950, at Montgomery Bell State Park, Dickson County, Tennessee. It was a medium sized adult and apparently typical of the species. Scale rows numbered 25, lower labials 10, dorsal blotches at anterior and posterior ends were concave.

The only published records I can find for this snake in Tennessee are a record from Madison County and a record from Chester County listed by Parker (Herpetologica, 4:79-80, 1947; and Jour. Tenn. Acad. Sci., 22:20-30, 1948.). This record from Dickson County extends the known range of this snake 80 miles to the east. Whether the range of *L. calligaster* overlaps with *L. rhombomaculata* is not known for Tennessee, but I have examined specimens of the latter from middle Tennessee which were in the live collection of the Childrens Museum at Nashville, Tennessee.—Ralph M. Sinclair, Shelby Forest State Park, Lucy, Tenn.

The Texan Hooded Snake in the Lower Rio Grande Valley of Texas

By Bryce C. Brown

First described over ninety years ago, the Texan hooded snake, *Tantilla nigriceps fumiceps,* has remained scarce in herpetological collections. Just seven individuals were found by Smith (Zoologica, vol. 27, no. 7, 1942, pp. 33-42) in his study of the genus *Tantilla* and only 28 Texan specimens could be found in the twenty-five museum and private collections examined by Brown (An Annotated Check List of the Reptiles and Amphibians of Texas, 1950, p. 184) in 1948. Twenty-six of the twenty-eight snakes were from no farther south than Atascosa and Medina counties, the only records from southern Texas being a very old specimen in the U. S. National Museum (No. 15,669) collected by W. J. Taylor at San Diego, Duval County and one from the Lower Rio Grande Valley labeled "shore of Bahia Grande, Cameron County" (Chic. N. H. Mus. No. 38,056) collected by C. T. Reed. Two other Texan hooded snakes have been recorded from Mier, Tamaulipas, Mexico (U.S.N.M. Nos. 46,584-5) just across the Rio Grande River from Roma, Starr County, Texas. Four additional *Tantilla nigriceps fumiceps* are now extant from the general area of the Lower Rio Grande Valley.

Three of the four snakes are females. Two of the females (B. C. B. Nos. 4843-4) are of special interest because of their very low ventral scale counts of 137 and 138 respectively. The normal range of ventral scale counts in female *Tantilla nigriceps fumiceps* is 141-150. The two unusual females were collected at Port Isabel in southeastern Cameron County on the shore of Laguna Madre by L. M. Brown. The third female (B. C. B. No. 628) was collected about 90 miles west of Port Isabel near La Joya School (10 mi. W. of Mission) in Hidalgo County by B. C. Brown. It has a ventral scale count of 146 which is well within the normal range given for females. The fourth specimen, a male, collected 2 mi. southeast of Rio Grande City, Starr County by L. M. Brown, has a ventral scale count of 134. This is about the average number in males (130-138).

The caudal scale counts of the 3 females are 41 in No. 4843, 40 in No. 4844, and 44 in No. 628, well within the caudal scale range of 39-44 for females of this form. The male has a caudal scale count of 52 which is considerably higher than that usually attributed to males (43-48). The other features of scutellation agree with the descriptions given by various authors. All of the snakes have 15-15-15 dorsal scale rows, 7 supralabials, 6 infralabials, 1 preocular, 2 postoculars, and 1-1 temporals. The V-shaped black cape extends posteriorly 3 to 3 1/2 scales behind the nape in all the specimens. The tail of the male measures 23.1 per cent of the total length while those of the females measure 17.1 to 18 per cent of the total length.

All four of the *Tantilla nigriceps fumiceps* were found in junk yards in typical mesquite chaparral country. Two were under old cardboard, one under a piece of gypsum wallboard, and the fourth was in the ground under a small cactus. All were collected near noon on warm sunny days during the winter and moved rapidly attempting to escape when first uncovered.—Strecker Museum, Baylor University, Waco, Texas.

NEW LOCALITIES FOR SEVERAL TEXAS SNAKES.—During the past three years, the writer has encountered several species of snakes in localities which appear to be new. These are listed below, and specimens of each form have been deposited either in the collection of Texas Christian University or in the writer's private collection.

Salvadora grahamiae lineata Schmidt. A single adult specimen was taken by the writer on July 23, 1949 near the Eagle Mountain Lake Dam, in Tarrant County, Texas, about 18 miles northwest of Fort Worth. Two juvenile specimens were taken on March 18 of the following year by members of the T.C.U. Herpetology Club at a locality approximately one and one half miles south east of the preceding locality. Both localities are along the eastern edge of the Western Cross Timber belt, where it joins the Fort Worth Prairie section of the county. The easternmost record for this subspecies indicated by Brown (An Annotated Check List of the Reptiles and Amphibians of Texas, 1950, Baylor University Press, Waco, Texas) is from Palo Pinto County, some 50 miles west of the present locality.

Arizona e. elegans Kennicott. One DOR and one live specimen, both juveniles and evidently of this subspecies, were taken by the writer September 1 1951 in Motley County, Texas, about 13 miles south of Turkey. The live specimen was found crawling across the road about 8:00 p.m. The scale count on the DOR individual, a male, is as follows: Anal entire, ventrals 212, caudals 60, dorsal formula 27-29-19, supralabiials 8-8, infralabials 12-12, preoculars 1-1, postoculars 2-2, temporals 2-2, no. of body blotches 51, tail blotches 20, total length 293 mm., tail length 44 mm. The locality at which these specimens were found is only a few miles east of the escarpment which forms the eastern boundary of the High Plains of Texas, and near the northern limit of the range at which this subspecies may be expected to occur, according to Klauber (The Glossy Snake, Arizona, with Descriptions of New Subspecies, 1946, San Diego Society of Natural History, Vol. X, No. 17, San Diego, California). A third specimen was found DOR between Turkey and Silverton, Texas but it was so badly mashed by traffic that it was not saved.

Sistrurus catenatus tergeminus (Say). A specimen of this subspecies was given to the writer September 21, 1951, by Mr. Tom Armstrong of Benbrook, Texas. It had been killed near Mr. Armstrong's home in Benbrook, less than a mile west of the western city limit of Fort Worth. This locality is in the Fort Worth Prairie, about one half mile north east of Mary's Creek. Although it had been shot in the head and the rattle had been removed, the specimen was in identifiable and preservable condition. Several of the residents of the area have reported having killed small rattlesnakes nearby "that were not diamondbacks." From these reports and the fact that we have an actual specimen, it seems likely that there is a small population of *Sistrurus c. tergeminus* in Tarrant County, at least in the section that lies immediately west of Fort Worth. The easternmost records listed for this subspecies by Brown (loc. cited) are from McLennan and Young Counties. The present specimen was taken about 70 miles north of McLennan and 70 miles east south east of Young County.—L. W. Ramsey, Texas Christian University, Fort Worth, Texas.

Notes on the Life History of the Puget Sound Garter Snake, THAMNOPHIS ORDINOIDES*

By William B. Hebard

The Puget Sound garter snake, *Thamnophis ordinoides,* has been described by Ruthven (1908) as a dwarf offshoot of the *elegans* group which exhibits the most extreme reduction in scutellation. Fitch (1940) has described the general characteristics and geographical variation of this species. Fox (1948) clarified the taxonomic position of *ordinoides* and separated it from the *elegans* group as a monotypic species. Inasmuch as *ordinoides* represents a northern dwarf offshoot from the widespread *elegans* species, a study was made to determine if *ordinoides* displays any marked differences from the life history studies reported in the literature for various other species of garter snakes.

Weekly collections were made during the period from March 15, 1948 until October 15, 1948 in King County, Washington. This time interval represents the period of activity for the year 1948. A total of 253 specimens was available for study. The data dealing with variation in body length, tail length, and scutellation have been reported previously. (Hebard, 1950.) This report is concerned with data regarding the reproductive cycle and size of broods.

Individuals were first seen on March 27; and considerable mating and copulatory activity was observed thereafter until the middle of April. Adult females captured from the middle of April to the first week in June had motile sperm present in the oviducts but had not yet ovulated. The maturing ovocytes were found to increase in size from an average of 3x5 mm. in the late fall to an average of 5x13 mm. by mid-April and to reach a maximum average-size of 6x18 mm. at the time of ovulation in early June. Ovulation occurred during the period from June 7 to June 15 and was coincidental with a rapid rise in air temperature. Upon inspection of the reproductive tract of adult females collected after June 15, it was noted that the mature ova were located in the oviducts.

The period of gestation extended from June 15 to about August 20, a period of approximately nine weeks. According to these observations, *T. ordinoides* has a shorter gestation period (approximately 63 days) than the period (87-116 days) of development reported for *T. sirtalis* by Blanchard and Blanchard (1940). Cieslak (1945) found the gestation period of *T. radix* to be approximately nine weeks.

Fall copulation and the presence of motile sperm in the uteri of adult females were noted from September 20 through October 9. *T. ordinoides,* like *T. sirtalis* (Blanchard and Blanchard, 1940), apparently carries on fall mating activity. Three out of five adult females collected on October 9 had motile sperm present in the uteri. By October 15 all individuals had apparently retired underground as none could be found in areas which were known to abound with snakes.

A series of 66 sexually-mature females provided data to make a correlation of body length with the number of embryos and also to determine the minimum body length of gestating females. According to the data compiled in Figure 1, the minimum body length of gravid females is about 330 mm.; and the number of embryos varies from 3 to 15 with an average number of 8.8. Burt (1928) reported that *T. s. sirtalis* has an average brood of 17 and *T. s. sauritus* an average of six young. Cieslak (1945) found that the average number of young for *T. radix* was 13. There was no apparent correlation between body length and number of embryos, although the females of body length 330-389 mm. had a maximum brood size of eight while the larger females of body length 430-469 mm. had as many as 15 em-

* This study was made possible by a research fellowship granted by the Graduate Research Committee, Department of Zoology, University of Washington.

bryos.

It is interesting to note that 33 per cent of the adult females were not gravid, and upon examination, pinkish ovarian scars were noticed. These scars, according to Cieslak (1945), represent the previous year's corpora lutea. This non-gravid condition in garter snake populations has been reported for other species. Burt (1928) noted that over half of the mature females of *T. s. sirtalis* were not bearing young. Siebert and Hagen (1946) found that over half of the adult female *T. radix* did not bear young. These observations suggest that perhaps a two-year reproductive cycle may be in operation in these populations. This was noted for the prairie rattler by Rahn (1942); however, Klauber (1936) presents data which suggest an annual cycle for a population of the same species living under similar environmental conditions, but Woodbury and Glissmeyer (1951: 24) present evidence that substantiates the two-year cycle. Blanchard and Blanchard (1940a, b) have demonstrated by breeding experiments that *T. s. sirtalis* is able to reproduce annually. As suggested by Rahn (1942), climate may be a critical factor in determining whether or not an extra year is needed for ovarian development. According to Cieslak (1945), *T. radix* displays a single annual rhythm in the Chicago area. The environmental and endocrine relationships affecting the development of the ova as well as the factors inducing ovulation in the garter snake are not well understood and in need of further experimental study.

SIZE CLASS mm.	NO.	% GRAVID	% NON-GRAVID	TOTAL EMBRYOS	NO. OF EMBRYOS Max.	Min.	AVERAGE NO. OF EMBRYOS
310-329	9	0	100	0	-	-	-
330-349	2	50	50	7	7	0	7.0
350-369	4	50	50	11	6	5	5.5
370-389	9	55	45	35	8	6	7.0
390-409	12	58	42	46	10	4	6.6
410-429	5	60	40	26	11	6	8.6
430-449	15	93	7	138	15	4	9.7
450-469	10	60	40	54	15	3	9.0
470-489	1	100	0	11	11	-	11.0
490-509	5	40	60	17	9	8	8.5
510-529	1	100	0	14	14	-	14.0
530-549	2	100	0	20	11	9	10.0
Totals	66 *	67%	33%	390	15	3	8.8

* Exclusive of 310-329 mm. class

Fig. 1. Relationship Body Length - Brood Size (T. ordinoides).

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LAMPROPELTIS DOLIATA REDISCOVERED IN ARIZONA.—The rediscovery of the western king snake (*Lampropeltis doliata gentilis*) in Arizona and the extension of its range into the north-central portions of the state is worthy of note.

A specimen of this snake was collected by the writer 37 miles north of Flagstaff, along highway 89. The locality is approximately 2 miles north of the west entrance to the Wupatki National Monument. It was found about 6:30 o'clock in morning, June 10, 1951.

Because of the extreme dryness of the season and excessive grazing on the adjoining range land the vegetation was sparse and there was little evidence of animal life. However, inside of the highway fences a healthy stand of desert shrubs and herbs lined each side of the highway. It was in this latter area that the specimen was found. There were also numerous lizards in this same area, representing species such as *Crotaphytus c. baileyi, Holbrookia m. approximans, Cnemidophorus septentrionalis* and *Urosaurus wrighti,* several specimens of each of which were collected.

From records at hand, no specimens of *Lampropeltis doliata gentilis* appear to have been noted from Arizona since the original specimens were listed by Yarrow in 1875 (1875: 537). These were collected by H. W. Henshaw in July, 1873, at Camp Apache, Cochise County, Arizona. Stejneger (1903), Blanchard (1921: 167-171) and Van Denburgh (1922: 745) all presumably refer to the specimens reported by Yarrow in 1875. Yarrow's only comment concerning this species was, "Tolerably common in Arizona." To date this has not proved to be the case, at least not in the southeastern part of the state where it was originally taken. Whether this species is a common inhabitant of north-central Arizona must yet be demonstrated by additional careful collecting. An examination of the king snakes in the collections of Arizona State College at Flagstaff, the Northern Arizona Museum (north of Flagstaff), and the Grand Canyon National Park did not reveal a single specimen of this species, although there were several of the Arizona king snake (*L. pyromelana*) in each collection.

The present specimen is an adult male 566 mm. in total length, and with a scale pattern as follows: dorsal rows 21-21-19-17, ventrals 180, caudals 45, supralabials 7-7, infralabials 9-9, preoculars 1-1, postoculars 2-2, temporals 2-3-3 on one side and 2-2-3 on the other. The color pattern consists of 34 white bands on body and tail, with the black cross bands partly or completely divided dorsally by a Dragon's-blood red, which shades laterally to a Coral red (Ridgway 1912). The black bands unite laterally but do not extend completely across the ventrals except on the tail where all form complete rings.

The rarity of records of this snake for Arizona may be due to the lack of collecting in its habitat or to the nocturnal and burrowing habits of the snake.

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Wilmer W. Tanner, Brigham Young University, Provo, Utah.

A New Geographic Race of Leaf-Nosed Snake from Sonora, Mexico

By Hobart M. Smith and Dave A. Langebartel.

Among the specimens secured by the junior author during a month's sojourn in the state of Sonora, Mexico, in June and July, 1951, is an example of a distinct race of *Phyllorhynchus decurtatus* occupying the southern part of Sonora and presumably northern Sinaloa. Four specimens of this race were tentatively regarded by Klauber (Trans. Zool. Soc. San Diego, vol. 9, 1940, p. 200) as intergrades between *P. d. decurtatus* and *P. d. nubilis*. We have seen one of these four, making a total of two examples examined of the race. In addition Mr. Klauber has generously made available his counts on the other three specimens. A number of distinctive features held in common by these five individuals, combined with the geographic isolation from the most similar populations (in Baja California), make clear the existence of a distinct geographic race.

Facilities for the expedition on which the single additional specimen was captured were provided by the University of Illinois Museum of Natural History through the kind offices of Dr. D. F. Hoffmeister, and, more extensively, by Dr. Frederick A. Shannon of Wickenburg, Arizona; to both we are very grateful. Financial support was provided through the generosity of Mr. Lester J. Norris. In appreciation of his contribution we name the race

Phyllorhynchus decurtatus norrisi
subsp. nov.
Sonoran Leaf-Nosed Snake

Holotype. Univ. Ill. Mus. Nat. Hist. No. 23887, secured 45.1 miles south of Santa Ana, Sonora, on July 3, 1951, by Dave A. Langebartel and R. Abbuhl. *Paratype*. E. H. Taylor No. 4579 (field no. 457), La Posa, near San Carlos Bay, Guaymas, Sonora, secured by E. H. Taylor, July 10, 1934. *Hypoparatypes*. *EHT No. 483, La Posa, Sonora; EHT No. 1100, 4 mi. N Guaymas; and Univ. Calif. Mus. Vert. Zool. No. 10170, Alamo Muerto, 30 miles west of Caborca, Sonora.

Description of holotype. Subadult male; total length (in preservative) 208 mm., tail 32 mm., ratio tail/total length 12.5 per cent.

Scale rows 21-19-16, dropping by loss of the fourth (third?) row to 20 at ventral no. 6, to 19 at no. 8; all except anterior scales in the two paravertebral rows on either side clearly keeled; scales in third paravertebral row on either side faintly keeled at midbody, clearly keeled posteriorly; vertebral row clearly keeled only posteriorly. Apical pits single; ventrals 154; anal entire; subcaudals 32, all divided.

Rostral very large, truncate in dorsal profile, edges protruding and striated; internasals triangular, separated by rostral, in contact with upper loreal and both sections of nasal; prefrontals in contact by a suture one-third to one-fourth the maximum length of either scale, in contact with upper loreal; parietals truncate at rear, little larger than frontal; supraoculars 1 1/2 times as wide at rear as at front, a little larger than internasals.

Nasal divided, posterior section higher than anterior and in contact with two anterior supralabials as well as all three loreals; anterior section of nasal in contact with first supralabial only; median loreal 2 1/2 times as high as long, in contact with a small loreal below and a still smaller one above; 1-2 preoculars; 3-3 suboculars; 2-2 postoculars; 3-3 tempor-

* Not examined, but certain data available.

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als on each side.

Supralabials 6-6, last largest, 2nd or 3rd smallest; 8-8 infralabials, 1st and 4th (5th) largest, 1st in broad contact with its mate on midline; anterior chinshields very large, in contact with 2(3) infralabials; posterior chinshields scarcely enlarged, widely separated from each other medially by a scale nearly equally as large.

Maxillary teeth 6 + 3, palatine teeth 2, pterygoid teeth 0 on each side.

Hemipenis very slightly bifurcate, with two nearly spineless longitudinal bands on either side, separated from each other by wider, spinous zones which merge together proximally but distally become narrower and slightly calyculate; spines gradually increasing in size proximally; sulcus apparently single but presumably forked near tip.

On body 29 subrectangular blotches, light-centered and dark-edged, separated from each other by spaces one or two scale lengths shorter than blotches; spots 8 to 11, usually 9 or 10, scale rows wide, 2 1/2 to 4 1/2 scales in length (except anterior two, which cover 5 or 6 scale lengths); a lateral row of small blotches on each side, alternating with dorsal blotches, situated on rows 3-5, occupying an area usually of three scale widths or less and of one scale length; entire ventral surface, and lower two dorsal scale rows, white, unpigmented; ground area on back with scattered gray stippling, nearly or quite absent at middorsal line. A long, diagonal dark streak on each side of nape beginning just back of parietals; an interrupted dark bar running forward between orbits and continued ventrad from orbit to near angle of jaws; forward of this mark, snout suffused and stippled with gray; a dark spot on rear of frontal, another on lateral edge of either parietal, and one at rear of midparietal suture; head otherwise light, with little stippling.

Variation. Scale counts in MVZ No. 10170 (M), EHT No. 4579 (F), EHT No. 723 (M) and EHT No. 1100 (M) are, respectively: median scale rows, 19, 21, 19, 19; ventrals, 156 166, 151, 151; caudals, 34, 23, 33, 31; supralabials 6-6, 7-6, 6-6, 6-6; infralabials 8-8, 9-9, 8-9, 9-9; loreals 2-2, 3-3, 2-2, 1-1; postoculars 2-2, 3-3, 3-3, 3-2; suboculars 2-3, 2-2,2-2, 2-2; trunk blotches, 31, 42, 23, 27; tail blotches, 6, 6, 6, 5. There is a scale between the prefrontals in No. 11070, and the prefrontals are slightly separated by rostral in No. 723. Keels are clearly visible even in the female, which measures 287 mm. in total length (tail 26 mm.). The head markings in No. 4579 are bold and more extensive than in the type, the lateral spots are a little larger, the ground color darker, and the dorsal spots more ovoid.

The single known female has many more blotches than the males, but it is highly improbable that a sexual difference of such magnitude would be borne out in larger series. It has 7 + 3 maxillary, 2 palatine and 0 pterygoid teeth on each side.

Comparisons. Eleven characters have been or can be used in distinguishing the various races of *P. decurtatus*. A summary of these for each race is given in Table 1. *P. d. norrisi* differs from its geographically closest relative (*P. d. perkinsi*) in relative lengths of dorsal spots and their interspaces, number and character of caudal spots, number of ventrals, number of pterygoid teeth, extent of head pattern and extent of clouding of background; in most characters there is a complete separation or very slight overlap. Perhaps more closely related, and at least more similar in most respects, is *P. d. decurtatus* of Baja California; it differs from *P. d. norrisi* in ventral counts, absence of keels, and in palatine and pterygoid tooth counts.

The phylogeny of these four races is controversial. Several different modes of phylogeny seem equally

Table 1

Comparisons of Characters in Four Races of

Phyllorhynchus decurtatus

	perkinsi	norrisi	decurtatus	nubilis
Ventrals	168-182	151-156	157-167	157-162
Ventrals	181-196	166	167-176	171-176
Caudals	32-41	31-34	33-36	30-33
Caudals	24-34	24	22-26	20-24
Trunk spots	24-48	23-42	18-33	42-60
Caudal spots	2-9	5-6	2-8	7-18
Palatine teeth	2-5	2	1	2
Pterygoid teeth	1-4	0	3	1
Keels	+	+	-	+
Interspaces	longer	shorter	shorter	shorter
Clouding	-	+	+	+
Lateral spots	-	+	+	+
Head pattern	-	+	+	+

plausible. Whatever the course may have been, the similarity of *P. d. norrisi* and *P. d. decurtatus* is here interpreted as a parallelism and not an indication of a closer relationship between these two forms than exists between either of them and others.

The importance of some of the characters here used is open to question. Counts on teeth of only two *P. d. decurtatus* and *P. d. nubilis* (in Bogert and Oliver, Bull. Amer. Mus. Nat Hist., vol. 83, 1945, p. 355) have been available for comparison with those from two *P. d. norrisi*. Known variation in *P. d. perkinsi* suggests that in other races as well a greater amount of variation is to be expected not only in tooth counts but also in scale and pattern counts. The variation curves of any or all the characters may overlap considerably with those for any other form, but a sufficient difference now exists on the basis of selected characters that even with the range of variation extended an adequate separation of the subspecies is to be expected.

Range. The record of *P. d. norrisi* from Alamo Muerto brings the known range of this race within about 110 miles of recorded localities of occurrence of *P. d. perkinsi* in extreme southwestern Arizona; the latter race also occurs in extreme northwestern Sonora, but specimens from the Punta Penasco-Sonoyta road, only 55 miles from Alamo Muerto, are dif-

ferent (Hensley, Trans. Kans. Acad. Sci., vol. 53, 1950, pp. 278-280). Hensley referred them to *P. d. nubilis*, but it is more likely that they are intergrades of *P. d. perkinsi* with *P. d. norrisi*. Clearer evidence of intergradation with *P. d. perkinsi* should be obtained with acquisition of specimens from the area between Alamo Muerto and Punta Penasco.—Department of Zoology and Museum of Natural History, University of Illinois, Urbana, Illinois.

The Identity of HYLA UNDERWOODI Auctorum Of Mexico

Hobart M. Smith (1)

Since 1935 the small frogs of Mexico referred by Kellogg(2) to *Hyla phlebodes* Stejneger (3) have been assigned to *Hyla underwoodi* Boulenger(4), an alternative name for *Hyla microcephala* Boulenger(5), preoccupied by *Hyla microcephala* Cope(6). The shift in terminology from *H. phlebodes* to *H. underwoodi* was proposed by Stuart(7) on the basis of Parker's comparison of the type of *H. underwoodi* with Guatemalan specimens referred by Kellogg to *H. phlebodes*.

Actually, Mexican specimens prove to belong to two distinct geographic races differing in certain characters which, although seemingly constant, are not conspicuously distinctive and would not ordinarily be detected except in comparison of series of individuals.

Of the forms thus far mentioned, *H. phlebodes* (of which Dr. E. H. Taylor has kindly loaned several examples) appears to be the most distinctive, having smaller finger webs (one-fourth instead of one-third webbed), no lateral dark band on sides of head and body, and other peculiarities. All of the other forms are, on the contrary, much alike in general character. There are slight differences in pattern, size of tympanum, size of pads, and position of vomerine teeth but the differences are not wholly constant, except perhaps in pattern, between some forms. It is here suggested that all represent geographic races of a single species, which by priority should be known as *H. microcephala* Cope.

Specimens now available do not make certain whether *Hyla microcephala microcephala* Cope and *Hyla microcephala underwoodi* Boulenger are recognizably distinct. There are possible differences in pattern, as the four *H. m. microcephala* from Colombia available to me (thanks again to the courtesy of Dr. Edward H. Taylor), as well as the two types according to Cope, have a linear pattern of

1. Department of Zoology and Museum of Natural History, University of Illinois, Urbana.

2. Bull. U.S. Nat. Mus., no. 160, 1932, pp. 172 - 173.

3. Proc. U.S. Nat. Mus., vol. 30, 1908, pp. 817, 818; type locality San Carlos, Costa Rica.

4. Ann. Mag. Nat. Hist., ser. 7, vol. 3, 1899, p. 277.

5. Proc. Zool. Soc. London, 1898, p. 481, pl. 39, fig. 3; type locality Bebedero, Costa Rica.

6. Proc. Amer. Philos. Soc., vol. 23, 1886, pp. 281 - 282; type locality Chiriqui, Panama.

7. Misc. Publ. Univ. Mich. Mus. Zool., no. 29, 1935, p. 39.

two lines on back between the lateral bands, whereas the two types of *H. m. underwoodi* do not. I have seen no examples of the latter form, however, and have depended upon Boulenger's description and figures for characterization. There is an additional difference, at least average, in size of tympanum in these two forms if Boulenger's description is correct that in *H. m. underwoodi* the tympanum is half the diameter of the eye. Cope says it is one-third in *H. m. microcephala,* and in the four specimens at hand it varies from slightly more than one-third (3) to slightly less than half (1). Finally, Boulenger describes the thighs as pigmentless — a condition approached but not attained by any other race of the species, although some related species (e.g., *H. robertmertensi*) lack thigh pigment.

Both *H. m. microcephala* and *H. m. underwoodi* differ from Mexican (and, presumably, Peten) specimens of the species in having 1) slightly larger pads on both manus and pes; 2) a pattern lacking irregular or x-shaped markings on back that merge with the lateral dark stripe where present; 3) the vomerine teeth closer together, as a rule (not invariably); 4) a larger tympanum, on an average (one-third to two-fifths eye diameter in northern specimens); and in other less tangible respects. In both of the southern forms the lateral dark stripe is the most prominent part of the pattern; in the Mexican races it is poorly defined and blends with other dark markings so that its presence or absence is sometimes an arbitrary decision.

The two Mexican races are restricted to one or the other coastal areas, one being known only from Guerrero, the other from central Veracruz to Peten. They differ chiefly in leg length, but also in pattern and to a less tangible degree in head width.

Thus four races of *H. microcephala* Cope seem to be recognizable at the present time. Other forms may be allied subspecifically. *H. phlebodes* probably belongs to the same group, but is certainly not a member of the same species. *H. robertmertensi* Taylor of Pacific Chiapas is of similar status; its completely pigmentless thighs, oblique vomerine teeth, and short finger webs clearly eliminate it from subspecific status with *H. microcephala.* The status of the apparently related *H. mocquardi* Gunther(8) is uncertain. The digital discs are exceedingly small, at least as shown in the figure and as described ("much smaller than tympanum"). Otherwise it closely resembles *H. m. underwoodi,* except possibly that the tympanum is slightly smaller ("two-fifths the area of the eye"). *Hyla uranochroa* Cope (9) from Costa Rica, said by Boulenger to be related to *H. m. underwoodi,* is widely different from this group, having a bluish dorsal coloration extending onto limbs.

Related more distantly would appear to be *H. smithi* of Pacific Mexico, and *H. picta* of Atlantic Mexico. Others of the *loquax* group (Smith and Taylor, Bull. U.S. Nat. Mus., vol. 194, 1948, pp. 78-79) in Mexico are scarcely to be regarded as close allies.

In any careful comparison of geographic forms of this group, due allowance should be made for the marked sexual dimorphism in size of digital pads, which are distinctly larger in proportion in females. The latter also seem to possess slightly larger tympana. As noted above, individual variation also exists in size and position of the vomerine teeth and in size of the tympanum.

Descriptions of the new Mexican races mentioned previously follow.

8. Biol. Centr. Amer., 1901, p. 268 pl. 73, fig. B; type locality either Guatemala or Panama.
9. Journ. Acad. Nat. Sci. Phila., n. s., vol. 8, 1876, p. 103.

Hyla microcephala sartori (10)
subsp. nov.

Holotype. Univ. Ill. Mus. Nat. Hist. No. 20934, an adult female from 1 mi. N Organos, S of El Treinte, Guerrero, collected by Edward H. Taylor and Hobart M. Smith on June 28, 1932. *Paratypes.* Twenty-five: UIMNH Nos. 20933, 20935, E. H. Taylor Nos. 3661-2, topotypes; UIM NH Nos. 20936-45, E. H. Taylor Nos. 18354-5, 18357-8, 18360-1, 18363-4, 18366-7, 18369, 18375-6, from El Limoncito, near La Venta, Guerrero, July 1, 1938; EHT Nos. 5884-5, El Treinte, Guerrero, July 30, 1936.

Range. Known only from central southern Guerrero in areas of tropical rain-forest. Habitat preference indicates a probable limitation to southern Guerrero and Oaxaca since more xeric conditions exist near the coast toward the mouth of the Rio Balsas and toward the Isthmus of Tehuantepec. No records in the literature for localities other than those cited in the preceding paragraph are known.

Diagnosis. A small *Hyla,* maximum snout-vent length about 28 mm.; yellowish or pale reddish purple, finely stippled with brown, with scattered coarse stipples on head, body and limbs; thighs with very few pigment granules; shank weakly barred; a dark line below canthus rostralis, above tympanum, extending posteriorly to level of axilla or to groin; digital pads about size of or slightly smaller than tympanum, which is one-third to two-fifths diameter of eye; fingers one-third webbed, toes four-fifths webbed; tarsal fold usually poorly defined, low; prevomerine teeth small, between choanae, nearer each other than choanae; tibiotarsal articulation to eye or tip of snout. Differing from other Mexican members of the species as follows: lateral dark stripe usually (88 per cent) not evident posterior to axilla, dorsal pattern rather consistently (81 per cent) cruciform, hind legs relatively short (heel reaching only to eye, to between eye and tympanum, or between eye and lores (100 per cent), Tibia usually (92 per cent) less than half snout-vent length); and head usually (88 per cent) little if any wider than body.

Description of holotype. Head a little narrower than body; canthus rostralis rounded; lores slightly concave, surface at a 45 degree angle with dorsal surface; width of eyelid (2.1 mm.) less than interorbital distance (2.3 mm.); length of eye (2.9 mm.) equal to its distance from tip of snout, nearly 3 times diameter of tympanum (1.0 mm.); latter round, overhung dorsally by a distinct ridge extending from posterior corner of orbit to middle of arm insertion.

Posterior sixth of tongue free; prevomerine teeth on a pair of small, rounded elevations between middle of choanae, nearer each other than internal nares; teeth in a single transverse row, the process somewhat oval in shape and slightly diagonal in position.

Belly and ventral surface of thighs granular; no anal flap.

Fingers one-third webbed; pads about size of tympanum; no postsubantebrachial ridge; palmar surface granular; a rather well-defined, small median palmar tubercle, and a slightly smaller outer one, as well as a large inner tubercle; subarticular tubercles single except under penultimate joint of outer and longest fingers, where a divided tubercle is present; supernumerary subdigital tubercles present un-

10. From the Latin *sartor,* meaning tailor; here used loosely in reference to Edward H. Taylor, who was responsible for accumulation of all known specimens of the present subspecies. No reference is intended to Carlos Sartorius, an earlier collector of some importance, most of whose material was obtained from the Mexican plateau and from Atlantic slopes.

der basal phalanges; axillary web well-defined, extending two-thirds the distance from arm insertion to elbow.

Heels slightly overlapping, reaching middle of eye when adpressed forward; toe pads little expanded, smaller than those on fingers; outer metatarsal tubercle small; tarsal fold poorly defined, reaching heel; web reaching pad of 5th toe, nearly reaching pad on posterior edge of 3rd toe, the notch of webs on two sides of 4th toe at level of 2nd subarticular tubercle.

Snout to vent, 26.0 mm.; width of head, 7.5 mm.; length of head from posterior border of ear, 7.9 mm.; foreleg from axilla, 15 mm.; hind leg from anus, 41 mm.; tibia, 13.3 mm.

Pale reddish brown above; all dark markings in form of concentrated stippling; sides of head and neck as far as rear level of axilla darker, light-edged above on a line from above naris along canthus and from rear corner of eyelid to above axilla; narrow dark lines on back forming a cruciform mark anteriorly, whose anterior arms reach eyelids, the posterior a point a third the distance from axilla to groin, these extending as low as a line between angle of jaws and groin (but not to level of axilla); another V-shaped mark on rear lumbar region; thighs with a few widely spaced dark pigment granules on dorsal surface only; shank weakly and narrowly barred; a few pigment granules scattered to either side of and below anus; venter unpigmented, except for a few granules on lower lip.

Variation. The sharpness of pattern varies considerably in the paratypes, but the details are remarkably constant. In most a narrow interorbital dark bar is present. The heel reaches a point between eye and ear, to as far forward as the rear of the lores, in all, and in all except the type and No. 18376 the tibia measures one-half, or less, of the snout-vent length. Females apparently are only slightly larger than males; two of the five available measure 26 mm., one 27 mm., snout to vent; the largest male measures 24.5 mm. in snout-vent length. Females differ from males also in size of digital pads and tympanum, both being smaller in proportion in males.

Remarks. Taylor's field notes on the El Limoncito series reads: "This species appeared for the first time after the hurricane on the night of July 1. I visited the pond on the previous night and not one *H. underwoodi* was seen or heard, although *Hyla staufferi* and *Hyla smithi* were seen and heard in large numbers." The topotype series was also taken in a period of torrential rains. Several visits under other conditions have yielded no specimens.

Hyla microcephala martini (11)
subsp. nov.

Type. Univ. Ill. Mus. Nat. Hist. No. 20965, from Encarnacion, Campeche, collected August 11 or 12, 1936, by H. M. Smith. *Paratypes.* Seventy-six including UIMNH Nos. 20948-64, EHT Nos. 12524, 12526-7, 12529-30, 12532-3, 12535-6, 12538-9, 12541-2, 12547-8, 12551, 12553-4, 12556-7, 12559-60, 12562-3, 12565, 12568-9, 12571-2, 12574-5, 12577-8, 12581, 12584,12586-7,topotypes; UIMNH No. 20944-6, EHT Nos. 12514-5, 12517-8, 12520-1, Balchacaj, Campeche; UIMNH No. 20947, EHT Nos. 12523, 12580, Tres Brazos, Campeche; UIMNH No. 20942, EHT Nos. 3664-5, 3667, 3669-71, San Andres Tuxtla, Veracruz; and UIMNH No. 20966, EHT No. 21712, Piedras Negras, Peten, Guatemala. All collected by H. M. Smith.

Range. Central Veracruz to Alta Verapaz, Guatemala, and probably British Honduras, northward in the

11. Named in honor of Mr. John T. Martin of Ciudad del Carmen, Campeche, with whose aid many of the type series were collected.

Yucatan peninsula to Chichen Itza, in areas of tropical rain-forest with or without savanna mixture. Locality records in Mexico other than those cited are from Palenque, Chiapas, Potrero Viejo, Veracruz, and Chichen Itza, Yucatan. The species occurs in Honduras and Nicaragua, but whether it is represented by this or another race is uncertain. It is replaced in at least Costa Rica by another race, *Hyla microcephala underwoodi*. Stuart (12) in the most reliable and thorough analysis of habitat preferences of this as well as many other species occurring in northern Guatemala, regards the species as restricted to the broadleaf forest of the lower division of the tropical zone, named by him the "corozo" belt, of which he says (p. 10), "this belt was probably originally covered with rain forest, but cultivation has modified the virgin condition." This association does not differ materially from that indicated by my own observations of the species in Mexico.

Diagnosis. Like *H. microcephala sartori* except: lateral dark stripe usually (97 per cent) visible nearly to groin; dorsal pattern usually (82 per cent) irregular, seldom clearly cruciform; legs shorter (heel usually (97 per cent) reaching a point between eye and tip of snout, or farther; length of tibia usually (96 per cent) more than one-half snout-vent length); and head usually (84 per cent) distinctly wider than body.

Description of holotype. Head distinctly broader than body; canthus rostralis rounded; lores slightly concave, surface (except near lip) at an angle of 45 degrees with dorsal surface of head; width of eyelid (2.2 mm.) less than interorbital distance (2.5 mm.); diameter of tympanum (1.3 mm.) about two-fifths length of eye (3.1 mm.); tympanum round, overhung by a distinct supratympanic ridge extending from posterior corner of orbit to middle of arm insertion.

Posterior fifth of tongue free; prevomerine teeth on a pair of small, rounded elevations between middle of choanae, about equidistant from each other and from choanae; teeth in a single, more or less transverse row, the process somewhat oval in shape and slightly diagonal in position.

Belly and ventral surfaces of thighs granular; a very short anal flap, lower edge near upper level of thighs.

Fingers one-third webbed (or one-fourth, according to system of determination); largest finger pads slightly larger than tympanum (all pads unusually large in females; they are proportionately smaller in males); no postsubantebrachial ridge; web between two outer fingers at level of antepenultimate articulation of outer finger; that between middle pair of fingers extending forward to level of middle third of antepenultimate phalanx of 2nd digit; web between 1st and 2nd fingers vestigial; palmar surfaces granular; a rather well-defined small median palmar tubercle, and a slightly smaller outer one, as well as a large inner tubercle; subarticular tubercles single except under penultimate joint of outer and longest fingers, where a divided tubercle is present; supernumerary subdigital tubercles present under basal phalanges; axillary web well-defined, extending two-thirds the distance from arm insertion to elbow.

Heels overlapping approximately 2 mm., reaching tip of snout when carried forward; toe pads smaller than finger pads, but well expanded (larger than in males); outer metatarsal tubercle scarcely evident; tarsal fold rounded but well developed, reaching heel; web reaching pad of 5th toe, nearly reaching pad of 3rd toe, the notch of webs on the two sides of 4th toe a short distance distal to level of 2nd subarticular tubercle.

12. Contr. Lab. Vert. Biol., no. 45, 1950, p. 24.

Snout to vent, 28 mm.; width of head, 8.7 mm.; length of head from posterior border of ear, 8 mm.; foreleg from axilla, 15 mm.; hind leg from anus, 45 mm.; tibia, 15 mm.

Yellowish above; back and head finely stippled with brown on an opaque whitish ground; no dorsal markings (males possess them); sides of head to level of canthus rostralis darkly pigmented, the pigment continuing posteriorly to form a dark area covering tympanum and extending in diminishing prominence to a point about halfway between axilla and groin; only a very narrow dorsal belt along thigh pigmented; distally considerable whitish pigment, disappearing near middle of thigh and dark pigment more scattered, sparse, absent on proximal fourth or third of thigh where no pigment whatever is present; shank pigmented like back, with no markings evident; venter immaculate except for a few granules of pigment near angle of jaws.

Variation. Females have wider pads (by actual measurement, and by proportion in comparison with tympanum), and a slightly larger tympanum, than males. The prevomerine teeth vary considerably in spacing, the two patches being very closely approximated in some, whereas in others they are as far apart as in the type; the latter is the typical condition. Variation in characters differing in the two forms is noted in the following.

Comparisons. The Guerrero specimens differ from Atlantic coast specimens in four respects: a greater regularity of the cruciform pattern, absence of the lateral dark stripe posterior to axilla, and in having shorter legs and a narrower head. No difference exists in webbing or size of pads.

In all except two *H. m. martini* (in which no pattern whatever is evident, even on head) the dark lateral stripe is at least discernible posterior to the axilla (in only three *H. m. sartori*), although the degree of distinctness varies in accordance with the distinctness of the rest of the pattern. In some well-marked individuals the stripe extends nearly to groin, and in others only a third the distance from axilla to groin.

In fourteen *H. m. martini* the dorsal pattern approaches the clearly cruciform pattern found in all except five of the Pacific subspecies; the pattern is openly reticulate at one extreme, and intermediate between that and the cruciform type in most others; in one a pair of wavy lines extends from eye to rump.

The heel in all but two *H. m. martini* (none of *H. m. sartori*) reaches to a point midway between eye and tip of snout, or farther, and in all but three (only two in *H. m. sartori*) the length of the tibia exceeds one-half of the snout-vent length. The standard error of the difference (.003) between the means of the two subspecies in ratio of tibia/snout-vent length is one-fifteenth the difference between the means (.045).

Direct comparisons show little overlap between the two races in width of head; twelve *H. m. martini* resemble the three broadest-headed *H. m. sartori*. Females of *H. m. martini* presumably are at least slightly larger than males; all seven females available measure 26 mm. or more snout-vent, whereas the largest male measures 25 mm.

Most significant and useful of these four differences, because of its objectivity, is the ratio of tibia to snout-vent length. The other differences are subjective to different degrees and would probably not be calculated at the same value by other students or even twice by the same student. The ratio mentioned above should, however, be correct within a few percentage points regardless of personal variates. The 92 per cent-96 per cent separation obtained thereby, supported

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Comparisons of Measurements in *Hyla microcephala*

	martini	*sartori*
Length of tibia, males.....	(70) 10.3 - 13.6 (12.7)	(21) 10.5 - 13.2 (11.4)
Length of tibia, females....	(7) 13.7 - 14.8 (14.1)	(5) 11.1 - 13.3 (12.3)
Snout-vent length, males....	(70) 20.0 - 25.0 (23.4)	(21) 22.2 - 25.0 (23.8)
Snout-vent length, females	(7) 26.0 - 28.0 (27.1)	(5) 24.0 - 27.0 (25.4)
Ratio, T/SV (*martini*)....	(77) .48 - .57 (.528 plus or minus .017, sigma .0019)	
Ratio, T/SV (*sartori*).....	(26) .46 - .51 (.483 plus or minus .013, sigma .0025)	

as it is by a separation of at least better than 75 per cent in three other characters seems wholly adequate for taxonomic recognition of the population involved and for ready identification even of small series.

Remarks. Inasmuch as these frogs appear to be restricted to very low elevations and areas of rain-forest (mixed with savanna in some cases), it is unlikely that the populations of the Atlantic and the Pacific slopes are in contact. A low but presumably effective barrier exists at the Isthmus of Tehuantepec, the only possible portal between their ranges. Despite this isolation the forms are regarded as subspecies because of the existence of at least some overlap in all characters separating them.

I am much indebted to Dr. Edward H. Taylor for advice and other assistance in studying this group of frogs, and to Dr. D. F. Hoffmeister for critical perusal of the manuscript.

THE SAN FELIPE ROAD—A SNAKE HUNTER'S DISAPPOINTMENT.—Cruising the paved highways of the desert is now an old-time method of hunting *Chionactis* and other nocturnal species, though the modern highways are not as advantageous as the earlier ones. With conditions just right—a sandy area covered with typical desert vegetation, a minimum of traffic, a road without high embankments or ditches and a warm, windless evening, it is a gamble at best whether results will be at all favorable.

The writer, in company with the late Wallace Wood, on May 12, 1941 journeyed over the salt flats and rugged terrain south of Mexicali on the so-called "road" to San Felipe, Lower California looking for future hunting ground in the territory the paved road to San Felipe, then under construction, was to traverse. We both agreed that the dirt road from Mexicali to El Mayor covered territory that offered no inducement, but beyond El Mayor was practically virgin territory for the snake hunter although the outlook was not too promising on account of the lack of sand dune areas, the whole country for miles around being nothing but a barren salt flat.

In May, 1951 in company with Dr. G. Dallas Hanna, of the Academy's staff, the writer gave the Mexicali-San Felipe Highway a thorough going over and it proved to be, from a snake hunter's point of view, a real disappointment.

The fact that it is banked up like a railway right-of-way is a great deterrent to any snake attempting to reach the pavement. Not a single dead lizard or snake was seen on the road from San Felipe to El Mayor during the four days we spent in the vicinity. At Los Medanos, about forty miles north of San Felipe, the road touches a drifting sand dune area where the sand was banked up against it. Here was the one and only lizard found on the road, a *Callisaurus*. Though the locality looked inviting reptile life was rather scarce, *Callisaurus, Cnemidophorus* and *Uma* being the only lizards seen. The type of dune and the general outlook appeared to be favorable for *Chionactis,* so just as it turned dark, we started over the dunes on foot making a zigzag course from bush to bush, each one being critically examined with our lights. From the numerous tracks observed it was easily seen that we were in first class *Chionactis* territory, but despite the fact that it was their period of activity on the surface we failed to capture a single snake. A second night netted the same results, though a few *Coleonyx* and a sidewinder were taken.

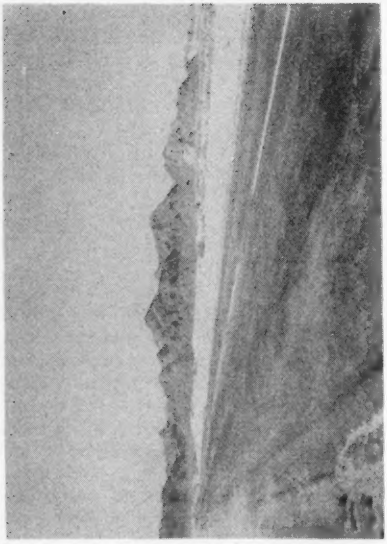
Chances are that future snake hunters on the Mexicali-San Felipe Highway will find Los Medanos the only spot worthwhile searching for the noctural desert snakes.—Joseph R. Slevin, California Academy of Sciences.

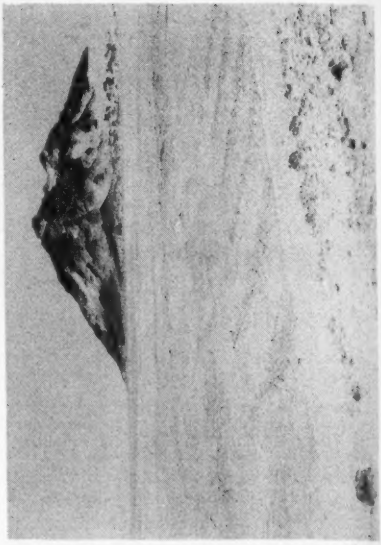
1. Drifting sands on the hillside in the vicinity north of Los Medanos. —Photo. by G. Dallas Hanna

2. At Los Medanos the highway passes through the only sand dune area en route to San Felipe. —Photo. by G. Dallas Hanna

3. The site of our camp south of Los Medanos and one of the few places it is possible to pull off of the highway. —Photo. by G. Dallas Hanna

4. A butte close to the highway appears as an island on the salt flat. —Photo. by G. Dallas Hanna





Notes on the Natural History of the Worm Snake, LEPTOTYPHLOPS HUMILIS

By Bayard H. Brattstrom and Richard C. Schwenkmeyer*

Notes on the natural history of the worm snakes are quite rare in the literature, the best summary being that of Klauber (1940). It is hoped that the following notes may help this situation.

The majority of these notes were taken in 1948 and 1949 but have been withheld until additional data on humidity could be obtained. Since then, the junior writer has joined the armed forces and it seemed best to publish what material was available at this time.

The observations presented herein are primarily on the Desert Worm Snake, *Leptotyphlops humilis cahuilae* and *L. h. humilis-cahuilae* intergrades, with a few notes on *L. h. humilis*, all from San Diego County, California.

ABUNDANCE

The number of worm snakes caught each year is usually determined by the activity and number of collectors and the condition of the roads traveled (*i.e.* paved roads being much better than dirt). The following is a yearly tabulation of worm snakes caught in the desert foothills of eastern San Diego County as taken from the records of L. M. Klauber and those of the writers:

1923-38	28	1944	0
1938	14	1945	2
1939	18	1946	0
1940	13	1947	1
1941	12	1948	40
1942	1	1949	29
1943	0		

The years of 1942-47 were during World War II when little collecting was done due to gas shortages.

*Now with the National Guard in Japan.

FOOD

Nothing is known of the food habits of *Leptotyphlops*, although it has been suggested by Klauber (1940: 148) that it probably consists of termites and other soft-bodied insects. The following is a tabulation of the worm snakes examined.

	cahuilae or intergrades	*humilis*
Number examined	52	50
Number with unidentifiable material	27	42
Number with sand	15	26
Number with parasites	32	13
Percent with parasites	61.5	26
Number with identifiable material	7	5

Seven of the digestive tracts of *cahuilae* or intergrade specimens contained material that was identifiable. Six of these specimens had termite (Isoptera) adults, workers, or eggs in them and one specimen contained six ants and eggs of ants (Hymenoptera-Formicidae). Three of the five specimens of *humilis* with identifiable material contained adult ants, while one contained larvae of ants. The fifth specimen had unidentified insect eggs in its stomach.

PARASITES

The number of intestinal round worms (Nematoda) found in the digestive tracts of these snakes was noted. The percentage of these parasites was highest in *cahuilae* and intergrades. The number of parasites in each individual varied from one to five in *humilis* to one to eleven in *cahuilae* and intergrades. The round worms have been identified by Dr. A. C. Walton of Knox College, Galesburg, Illinois, as being members of the genus *Parathelandros*.

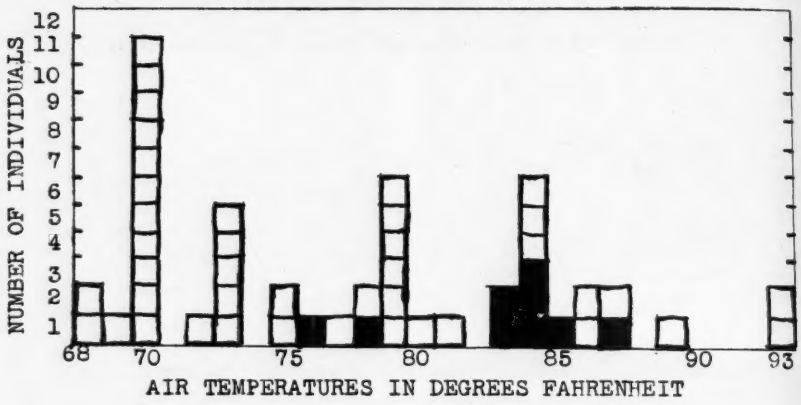


Fig. 1. Air temperatures near the ground at which *Leptotyphlops* have been taken on the road in Eastern San Diego County, California. Each square represents one individual. Dark squares are *L. h. cahuilae* and light squares are *L. h. **humilis-cahuilae*** intergrades from Sentenac Canyon.

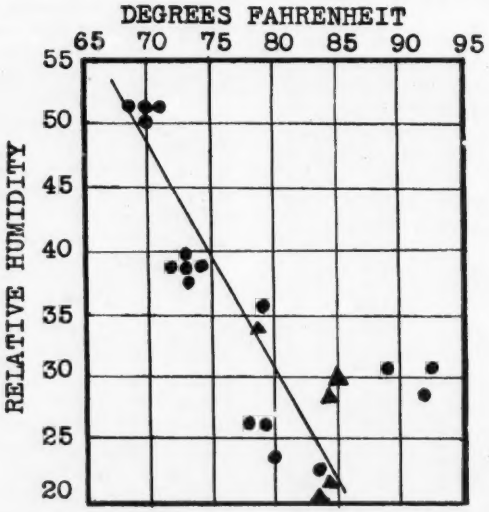


Fig. 2. Graph showing the relationship between air temperature and relative humidity near the ground at times when worm snakes were caught on the road. Circles are intergrade specimens and triangles are pure *cahuilae*.

All of the parasites were found in the top or anterior portion of the intestinal diverticulum or colic caecum. This caecum is evidently present in most lizards. (*Phyllodactylus, Coleonyx, Sceloporus, Sauromalus, Amphisbaena, Rhineura* and *Bipes*), but is lacking in some (*Anniella, Uta, Uma, Dipsosaurus* and *Crotaphytus*). In snakes, this caecum has been found in *Leptotyphlops, Typhlops punctatus, T. alvensis, Constrictor, Charina, Lichanura, and Cylindrophis*, but not in *Typhlops braminus, Epicrates*, or *Enygrus*. It is not present in the Crotalidae (*Crotalus*), Elapidae (*Micruroides*), Hydrophiidae (*Platurus*), or Colubridae (*Lampropeltis, Phyllorhynchus, Chionactis, Sonora, Pituophis, Hypsiglena, Rhinocheilus, Oxybelis, Conophis* or *Carphophis*.) Its presence in some snakes may indicate some relationships, but further data on internal anatomy of snakes are needed.

MOONLIGHT

Whether or not the moon has any effect on the activity of snakes has been a controversial subject for many years. Of nineteen desert trips taken by the writers in 1948-49, twelve trips were taken in the moonlight and seven were taken in the dark of the moon. Only six specimens of both *cahuilae* and intergrades were captured on moonless nights, while twenty-eight were taken in the presence of the moon.

TEMPERATURE AND HUMIDITY

Klauber (1940) makes note of the maximum (87°F.), minimum (68°F.), and optimum (78°-82°F.) desert air temperatures at which worm snakes have been taken on the roads at night. The records of the writers, from eastern San Diego County, are presented in Fig. 1. The highest (93°F.) and the lowest (68°F.) records are those of intergrade specimens. The highest and lowest record for *cahuilae* were 87°F. and 76°F. respectively. The average for intergrades was 73°F. whle 84°F. was the average for pure *cahuilae* specimens and 77°F. the average for all specimens. These differences are probably due to the difference in habitats between Sentenac Canyon whre the intergrade specimens are found, and Yaqui Well to the Narrows where true *cahuilae* have been collected. (See Klauber, 1940, p.p. 127, 136-7, 147. 1939, Table No. 15.)

Until the present time, the ecological relationships of humidity have been neglected. The material presented in Fig. 2. shows an interesting correlation of the relative humidity and air temperatures at times when worm snakes were taken and suggests that further work should be done along this line, but it should be remembered that the air temperature and humidity recorded should be that near the ground where the animals are living as has been done in this case.

The data in figurges 1 and 2 were taken by means of a Fee and Stemwedel "Airguide" thermometer and hair hygrometer which is checked periodically for accuracy. The instrument is placed on the road where the snake is collected and records conditions between 1 and 7 cm. above the road. (See Woodbury and Hardy, 1948.)

PROTECTION

Mosauer (1936) mentions the presence of a "clear, watery, odorless" fluid being emitted from the vent of these snakes when captured. It was noted by the writers in 1948, that this fluid has a very strong musky odor which will remain on the hands for a few hours if not washed. This is a practice common among snakes, especially *Thamnophis, Natrix*, and *Elaphe*, and it would seem to be quite advantageous to these small snakes.

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San Diego Society of Natural History, San Diego, California

TWO ADDITIONS TO THE HERPETOFAUNA OF BAJA CALIFORNIA, MEXICO.—Two species expected, but as yet (Smith and Taylor, 1945, 1948) unrecorded from Baja California, Mexico, were taken by the writer on June 13, 1951 in the partly irrigated district below Mexicali in the northeast section of Baja California. Both forms are relatively common in the irrigated district about Imperial Valley, California.

Bufo alvarius: One specimen of the Colorado River Toad was taken at 7:40 p.m. approximately 4.7 miles north of El Mayor (El Mayor is about 40 miles south of Mexicali), Baja California, Mexico. It was on the paved road, hopping toward a permanent pool of water.

Thamnophis marcianus nigrolatcris: Two specimens of this garter snake were taken, one alive at 7:45 p.m. and one D.O.R. at 8:45 p.m. 4.8 and 29 miles north of El Mayor, respectively. The former was in an area of permanent pools and irrigation ditches while the latter was in an area apparently without water.

The specimens are now in the collection of the San Diego Society of Natural History.

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—Bayard H Brattstrom, San Diego Society of Natural History.

Nomenclature Remarks on Some Generic Names of the Snake Family Boidae*

By Lothar Forcart

*Contribution from the Museum of Natural History of Basle, Switzerland.

In revising the Boidae of the Museum of Natural History in Basle (Switzerland) I observed some names in Stull's Check List of the Family Boidae (1935) which are not in accordance with the International Rules of Zoological nomenlature.

Boa Linne = Corallus Daudin

Stull accepted the designation by Stejneger (1901: 185) of *Boa canina* Linnaeus, 1758, as type species of *Boa* Linnaeus, 1758. Stejneger (1901: 184-185) based this designation on a process of elimination in Laurenti (1758: 88-89 and 106-109).

The process of elimination is not accepted by the International Rules on Zoological Nomenclature. The type selection by Fitzinger (1843: 24), who designated *Boa constrictor* Linnaeus, 1758, as genotype of *Boa* Linnaeus, is valid.

The genus *Boa* Stejneger, 1901 (non Linnaeus, 1758), with *Boa canina* Linnaeus, 1758, as type species, is a synonym of *Corallus Daudin*, 1803. The genus *Corallus* was first published by Daudin (1803a: 434) without mentioned species. It was based on the specimen described and figured by Merrem (1790: 14, pl. 2) as "Stumpfkopfiger Schlinger," named later *Boa merremi* by Sentzen, 1796, and *Corallus obtusirostris* by Daudin, 1803 (1803b: 259). By monotypy, *Corallus obtusirostris* Daudin is the type species of *Corallus*; that name is a synonym of *Boa merremi* Sentzen, since both names were based upon the same "indication" and Sentzen's name is the earlier. Both are in turn, however, synonyms of *Boa Enydris* Linnaeus, 1758.

Species and subspecies currently recognized in this genus are as follows (author of combination cited in parentheses after author of name):

Corallus annulatus (Cope), 1876 (Boulenger, 1893)

Corallus caninus (Linnaeus), 1758 (Boulenger, 1893)

Corallus enydris enydris (Linnaeus), 1758

Corallus enydris cookii Gray, 1842

References and brief synonymies may be found in Stull (1935: 398).

Enygrus Wagler = Candoia Gray, 1842

Fitzinger (1843: 24) selected *Enygrus regius* (Shaw) = *Boa regia* Shaw, 1802, as type species of *Enygrus* Wagler, which was originally proposed to contain this and two other species. Consequently *Enygrus* Wagler, 1830, is a synonym of *Python* Daudin, 1803.

The name *Enygrus* for the genus containing *Boa carinata* Schneider must be replaced by *Candoia* Gray, 1842 (Zool. Misc.: 43) whose type species (monotypical) is *Candoia carinata* (Schneider) = *Boa carinata* Schneider, 1802.

Species and subspecies currently recognized in this genus are as follows (author of combination cited in parentheses after author of name):

Candoia aspera aspera (Gunther), 1877

Candoia aspera schmidti (Stull), 1932

Candoia bibronii bibronii (Dumeril and Bibron), 1844

Candoia bibronii australis (Montrousier), 1860

References and brief synonymies may be found in Stull (1935: 399-400).

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Peropodum Muller = Ungaliophis Muller, 1882; Peropodum guatemalensis Muller = Ungaliophis continentalis Muller, 1882

Stull (1935: 403) based these names on Bocourt (1882: 532-534) who used the generic name *Peropodum* Muller with *Peropodum guatemalensis* Muller as the only species. As Muller later (1884: 298) pointed out, he (Muller, 1878: 573-591, 652, 709, and pl. I) had indeed described a new Boid of Guatemala, but he did not then (1871) name it. He referred to it (1878) as follows:

p. 591: "Nov. gen. Boid. Affin. Ungal. (Anm. 13) Spec. guatemalensis a. Retulueu, costa grande v. Guatemala, gesch. y. Dr. G. Bernoulli 1877. (1)."

p. 652: "(13 Boaeide von Guatemala Peropodum n. sp. et genus? (hiezu Tafel I). (Costa grande.)"

Then follows the description of the snake.

On p. 573 he mentioned it in the list of Amphibians and Reptiles from Guatemala as "Boadarum n. gen. et sp.?", and on p. 709 occurs the following in the explanation of the plates: "Taf. I. Boidarum nova species (et genus novum?). (Costa grande von Guatemala)."

Peropodum on p. 652 means not a generic name but a taxonomic "division" of snakes equivalent to the Boidae as at present understood. Dunn and Bailey (1939: 6) have already pointed this out, and accordingly the genus has been accepted in some faunal lists (e. g., Smith and Taylor, 1945, Bull. U.S. Nat. Mus., 187: 26) as *Ungaliophis*.

Spec. guatemalensis (Muller 1878: 591) means a species of Guatemala and is no specific name.

Muller (1882: 142) did name this species with the following words: "Ich habe es damals unterlassen einen Namen dafur vorzuschlagen, in der Hoffnung, dass diese Schlange schon irgendwo beschrieben worden sei; da mir aber seit der Veroffentlichung keinerlei Notiz daruber zugekommen ist, so schlage ich den Namen *Ungaliophis continentalis* vor."

The author of the generic name *Peropodum*, and the species *Peropodum guatemalensis* is consequently Bocourt, 1882, and not Muller.

Ungaliophis continentalis Muller, 1882, and *Peropodum guatemalensis* Bocourt, 1882, are based on the same holotype (Mus. Basel No. 427). Separate printings of the publication containing the description of *Ungaliophis* Muller were published in 1880, but the periodical, which contained it, was not published before 1882. It is impossible to fix the date of the publication, so that *Ungaliophis continentalis* and *Peropodum guatemalensis* must be regarded as published on the same date. Cope (1887: 65), upheld by Boulenger (1893: 114) has chosen *Ungaliophis continentalis* Muller as first reviser, and consequently this name must be used.

Genus Constrictor Laurenti = Boa Linnaeus, 1758

As mentioned above the selection by Fitzinger (1843: 24) of *Boa constrictor* Linnaeus, 1758, as type species of *Boa* Linnaeus, 1758, must be accepted.

Constrictor Laurenti (1768: 106-109) contained originally the species *Constrictor formossimus* Laurenti, *Constrictor rexserpentum* Laurenti, *Constrictor auspex* Laurenti, *Constrictor diviniloquus* Laurenti, and *Constrictor orophia* Laurenti. Of these species I am selecting *Constrictor formossimus* Laurenti, which through its bibliographic reference "Seba I. 36. 5" is a synonym of *Boa constrictor* Linnaeus, as type species of *Constrictor* Laurenti.

Consequently *Constrictor* Laurenti is a synonym of *Boa* Linnaeus. Species and subspecies currently recognized in this genus are as follows (author of combination cited in paren-

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theses after author of name):

Boa constrictor constrictor Linnaeus, 1758

Boa constrictor amarali (Stull), 1932

Boa constrictor imperator Daudin, 1803

Boa constrictor occidentalis Philippi, 1873

Boa constrictor sabogae (Barbour), 1929

Boa constrictor sigma (Smith), 1943

Boa orophias Linnaeus, 1758 (Linnaeus, 1758)

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NOTES ON THE FEEDING HABITS OF *CROTOPHYTUS RETICULATUS*.—In May of 1950, a large captive *Crotophytus reticulatus*, collected near Arroyo Dolores, Zapata County, Texas, was observed in the act of engulfing an adult *Cnemidophorus gularis* from the same locality. This seems to be the only record of *reticulatus* feeding in captivity. Smith, in the "Handbook of Lizards" says; " . . . in captivity they could not be made to eat or drink." Later it was found that this form would accept *Cnemidophorus* regularly, but would not accept *Anolis* or *Sceloporus*. It was noted that *C. gularis* was the most abundant lizard seen in most of the areas where C. reticulatus was collected. This suggests the idea that proper foods and proper ecological conditions in cages may be necessary in order to rear certain species in captivity.—Theodore Klein Jr., Texas Military Institute, San Antonio, Texas.

A NEW METHOD OF COLLECTING *HOLBROOKIA TEXANA*.—In June of 1949, while collecting *H. texana* on some limestone flats near Selma, Bexar County, Texas, it was noted that the majority of specimens seen in the open would take refuge under rocks where many were crushed while turning the rocks over. It was found by experiment that when my hat was tossed on the ground several feet from the lizards that the majority would run under it to obtain shelter when disturbed. The sides of the hat were then pinched together and the lizard was easily removed. A large series of *Holbrookia* and several *Cnemidophorus gularis* were collected in this way. This method should prove helpful in collecting a number of terrestrial lizards which have the same inclination to go under rocks and other debris when excited.—Theodore Klein Jr., Texas Military Institute, San Antonio, Texas.

TWO NEW RECORDS FOR *ELEUTHERODACTYLUS RICORDII PLANIROSTRIS* IN THE BAHAMA ISLANDS.—The American Museum has recently received specimens of *E. r. planirostris* that show this frog to be more widely distributed in the Bahama Islands than I had earlier reported (Goin, 1947, Univ. Fla., Biol. Sci. Series, vol. IV, no. 2). Since publication of the then available records, Dr. James A. Oliver has collected twenty specimens in September and October, 1947, on South Bimini (AMNH 53641-54+6) and Mr. George Campbell has collected five specimens at Hatchet Bay, Eleuthera, April 5, 1948 (AMNH 54152-56).

The Bimini specimens are all mottled. The mottling on the backs of these specimens is a little finer and the specimens seem slightly paler than topotypes from New Providence; otherwise they are very similar. The ten largest specimens range in snout-to-vent length from 18.3 mm to 28.8, average 20.9; in head width from 7.1 to 10.5, average 7.9; tibio-fibula length, 8.4 to 12.1, average 9.7.

The Eleuthera specimens are all mottled and have an even finer motling than the Bimini individuals, some of them approaching the color pattern of Cat Island individuals A very narrow mid-dorsal keel seems to be more pronounced on them than on topotypes. In snout-to-vent length they range from 13.4 to 26.4, average 20.2; in head width from 5.1 to 11.4, average 8.0, and in tibio-fibula length from 6.3 to 13.5, average 9.6.—Coleman J. Goin, University of Florida, Gainesville, Fla.

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